

# Dell EMC SC Series Storage and SMI-S Integration with Microsoft SCVMM

Dell EMC Engineering  
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## Revisions

Date	Description
May 2012	Initial release of SCVMM 2012 for Microsoft® Windows Server® 2008 R2
February 2013	Updated for Windows Server 2012 and SCVMM 2012 SP1
December 2013	Updated for SCVMM 2012 R2
November 2016	Updated for SCVMM 2016
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## Acknowledgements

This document was authored by Marty Glaser, a member of the Dell EMC Storage Applications Engineering team.

## Feedback

We welcome your feedback along with any recommendations for improving this document. Send comments to [StorageSolutionsFeedback@dell.com](mailto:StorageSolutionsFeedback@dell.com).

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Dell believes the information in this document is accurate as of its publication date. The information is subject to change without notice.

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## Executive summary

This document provides step-by step guidance for the following:

- Enable the Dell EMC™ SC Series SMI-S provider and configure Microsoft® System Center Virtual Machine Manager (SCVMM) to manage SC Series storage
- Use SCVMM to discover, classify, and manage SC Series storage
- Configure the SCVMM fabric
- Create SAN copy-capable templates to facilitate rapid provisioning of Microsoft Hyper-V® guest VMs on SC Series storage
- Leverage SMI-S for SAN transfers when migrating guest VMs

# 1 Introduction

SC Series storage has supported SMI-S integration with SCVMM since the release of Dell Storage Center OS (SCOS) 6.3.1 and SCVMM 2012. With each subsequent release of SCVMM (2012 SP1 and 2012 R2), this guide was updated. This document features SCVMM 2016, along with Dell Storage Manager (DSM) 2016 R3 and SCOS 7.2.

## 1.1 Audience

This document is for technology professionals interested in learning more about how to configure SMI-S to manage SC Series storage and create SAN copy-capable templates for rapid provisioning of new guest VMs. Readers should have working knowledge of SCVMM and SC Series storage.

## 2 Overview

This section provides a brief overview of the major components required to configure the environment.

### 2.1 SC Series storage

SC Series storage solutions provide many robust features such as true flash optimization, thin provisioning, data optimization, data reduction (deduplication and compression), automated sub-LUN tiering, sub-disk RAID levels, synchronous replication with automatic failover, and intelligent read and write data placement. SC Series arrays provide a unified platform for the ultimate experience in performance, adaptability, and efficiency.

In addition to raw capacity and I/O performance, other important factors such as monitoring, reporting, trending, protection of the data (backups, snapshots, and replication), and the ability to recover in case of a disaster are equally important. The SC Series array is well suited to provide solid, proven solutions to Hyper-V and SCVMM environments to meet these business needs. To learn more about SC Series storage arrays, visit the [SC Series Storage](#) page.

#### 2.1.1 Supported SCOS versions

SCOS version 7.1 or newer is required to support Windows Server 2016. SCOS version 7.2 is required to support SCVMM 2016. For older versions of SCVMM (2012, 2012 SP1, 2012 R2), SCOS 6.3.1 or newer is required.

### 2.2 Dell Storage Manager and SMI-S provider

The Storage Management Initiative Specification (SMI-S) is an industry-standard protocol developed by the Storage Networking Industry Association (SNIA) that allows third-party applications to interface directly with SAN storage. In the case of SC Series arrays, SMI-S integration enables SCVMM users to perform a subset of SAN operations from within SCVMM, such as provisioning new LUNs.

Although it might be possible to configure other third-party applications to integrate with SC Series storage through SMI-S, this integration is officially supported with SCVMM 2012 and newer versions only.

The SC Series SMI-S provider comes bundled at no additional cost with the DSM Data Collector.

**Note:** Enterprise Manager (EM) was rebranded as DSM upon release of DSM 2016 R1. This guide features DSM 2016 R3.

SMI-S can be enabled and configured at the time DSM or EM is installed, or anytime thereafter.

For more information, see the *Administrator's Guide*, *Installation Guide*, and *Release Notes* for your version of DSM or EM on the [Dell Support](#) site.

### 2.2.1 Supported DSM versions

SCVMM 2016 requires DSM 2016 R3 or newer. For prior versions of SCVMM (2012, 2012 SP1, 2012 R2) DSM 2016 R1 or newer is recommended, however, older versions of Enterprise Manager (EM) back to 6.3.1 are supported. Using the latest version of DSM is highly recommended to take advantage of the latest enhancements and bug fixes.

## 2.3 Microsoft System Center Virtual Machine Manager

Microsoft System Center is a cloud and data center management suite that provides a common toolset for public and private cloud services.

SC Series arrays support SMI-S integration with SCVMM 2012 and newer. The figures and examples in this guide feature SCVMM 2016.

SCVMM is a component of the System Center suite and allows administrators to:

- Deliver Infrastructure as a Service (IaaS). Data center resources such as processing, networking, and storage can be pooled and virtualized and made available through self-service, role-based user access.
- Virtualize applications and services to be managed independently from the underlying infrastructure.
- Optimize and manage multi-hypervisor environments such as Hyper-V, Citrix® XenServer®, and VMware®.
- Dynamic optimization of data center resources based on workload demands.

### 2.3.1 SCVMM components

A typical deployment of SCVMM includes the following components, which may be installed on the same server in smaller environments, or different servers in larger environments:

- SCVMM server (the SQL Server® database component)
- SCVMM Administrator Console (the management GUI)
- SCVMM library server
- SCVMM command shell

### 2.3.2 SCVMM fabric

Central to the functionality of SCVMM is the configuration of the SCVMM fabric. In SCVMM, the fabric includes all the underlying hardware components and other resources that are required for administrators and self-service role users to create and manage physical hosts and guest VMs.



Configuring the basic elements of the fabric is necessary before deploying guests or creating a private cloud. The following components are part of a basic fabric configuration:

**Storage:** In this guide, an SC Series array is discovered through SMI-S and used for storage. This requires SCVMM 2012 or newer, with SCVMM 2016 featured in this guide.

**Host group:** This is a logical grouping of one or more clustered or standalone physical hypervisors that serve as targets for resources such as deployed guest VMs. Hyper-V is featured in this guide.

**Library server:** This contains a catalog of files, scripts, installers, ISOs, virtual hard disks, hardware profiles, OS profiles, and templates used for deploying hosts and guest VMs.

**Physical hypervisor hosts:** VMware ESX®, XenServer (SCVMM 2012 versions only), and Hyper-V are supported. This guide features Hyper-V.

**Networking components:** These include logical IP networks, static IP pools, MAC address pools, load balancers, and so forth.

To learn more about SCVMM, including tools, videos, blogs, and the feature enhancements that have been made available with each new release of SCVMM, visit the [Microsoft TechNet Library](#).

## 2.4 Microsoft Hyper-V

The Windows Server platform leverages Hyper-V for virtualization technology. Initially offered with Windows Server 2008, Hyper-V has matured with each release to include many new features and enhancements. With the release of Windows Server 2016, Hyper-V is also supported on Nano Server in addition to Server Core and Server with Desktop Experience.

Microsoft Hyper-V has evolved to become a mature, robust, proven virtualization platform. At a basic level, it is a layer of software that presents the physical host server hardware resources in an optimized and virtualized manner to one or more guest virtual machines (VMs). Hyper-V hosts (also referred to as nodes when clustered) can greatly enhance host server hardware utilization (including processors, memory, NICs, and power) by allowing many VMs to share these resources at the same time. Hyper-V Manager and related management tools (such as Failover Cluster Manager, Virtual Machine Manager, and PowerShell) offer administrators great control and flexibility for managing host and VM resources, VM mobility, SAN storage, balancing workloads, provisioning systems, and ensuring quick recovery.

To learn more about Hyper-V, including tools, videos, blogs, and the feature enhancements that have been made available with each new release of Hyper-V, visit the [Microsoft TechNet Library](#).

In addition to this document, the [SC Series Technical Documents](#) page at Dell TechCenter contains deployment guides, demo videos, and reference architectures in support of single and heterogeneous application workloads running on Hyper-V and SC Series arrays, including Microsoft Exchange, Microsoft SQL Server, and VDI.

### 3 Prerequisite steps checklist

Complete the steps in Table 1 before proceeding with the rest of this guide. Refer to the *Administrator's Guide* for your version of DSM or EM for guidance with these steps.

Table 1 Prerequisites

Step	☑	Details
1	<input type="checkbox"/>	Install and configure the Dell Storage Manager (DSM) Data Collector on a host server or VM. If using SCVMM 2016, DSM 2016 R3 (featured in this document) is recommended. For SCVMM 2012, DSM 2016 R1 is strongly recommended, but Enterprise Manager (EM) version 6.3.1 or newer is also supported. Install the DSM client on the same or a different server or workstation.
2	<input type="checkbox"/>	Complete the SMI-S configuration steps in the DSM or EM <i>Administrator's Guide</i> to verify software, firewall, and registry settings on the DSM, EM, and SCVMM servers.
3	<input type="checkbox"/>	Make sure the DSM/EM Data Collector and SCVMM are installed on separate physical or virtual servers which use their own unique database instances.
4	<input type="checkbox"/>	Ensure the DSM/EM Data Collector and SCVMM servers are members of the same Active Directory domain.
5	<input type="checkbox"/>	Verify that Microsoft SCVMM is installed according to Microsoft best practices. This includes configuration of the SCVMM library server. SCVMM 2012 is the minimum supported version. SCVMM 2016 is featured in this guide.
6	<input type="checkbox"/>	Create SAN copy-capable VM templates for rapid-provisioning of VMs by installing the library role on a physical host server that has access to the managed SC Series storage array and has the Hyper-V role installed. This configuration is used in this guide.
7	<input type="checkbox"/>	Make sure at least one physical Hyper-V host server (besides the library server) is available to SCVMM for placement of VMs.
8	<input type="checkbox"/>	Configure all components in the environment to use a single common transport (Fibre Channel or iSCSI). SCVMM SMI-S integration with a SAN does not support using mixed transports. In the examples shown in this guide, the SCVMM server, library server, Hyper-V hosts, and SC Series arrays are all configured to use Fibre Channel with MPIO.
9	<input type="checkbox"/>	Ensure that Dell SC Series arrays managed by SCVMM are running SCOS version 6.3.1 or newer (for Windows Server 2012/R2 and SCVMM 2012/SP1/R2). SCOS 7.2 is required to support SCVMM 2016, which is featured in this guide. For all versions of Windows Server and SCVMM, upgrading to SCOS 7.2 is recommended to take advantage of the latest enhancements and bug fixes.

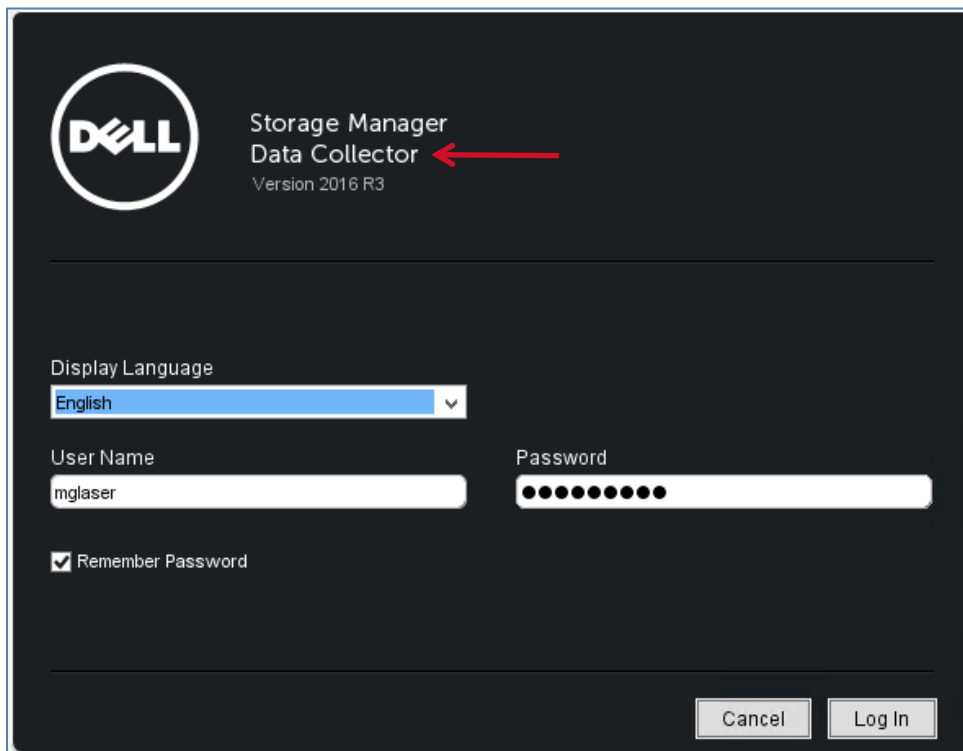
## 4 Enable SMI-S on the DSM Data Collector

Refer to the *Dell Storage Manager Administrator's Guide* to complete the following steps to enable SMI-S on the DSM Data Collector.

**Note:** The following steps feature DSM 2016 R3, which is required for SCVMM 2016. DSM 2016 R1 and newer come with version 1.6 of the SC Series SMI-S provider (based on JWBEM). Data Collector versions prior to DSM 2016 R1 come with version 1.5 of the SMI-S provider (based on OpenPegasus) and require extra configuration steps (automated with PowerShell) to create an OpenPegasus user and a local Windows user account on the Data Collector server. See appendix B for details.

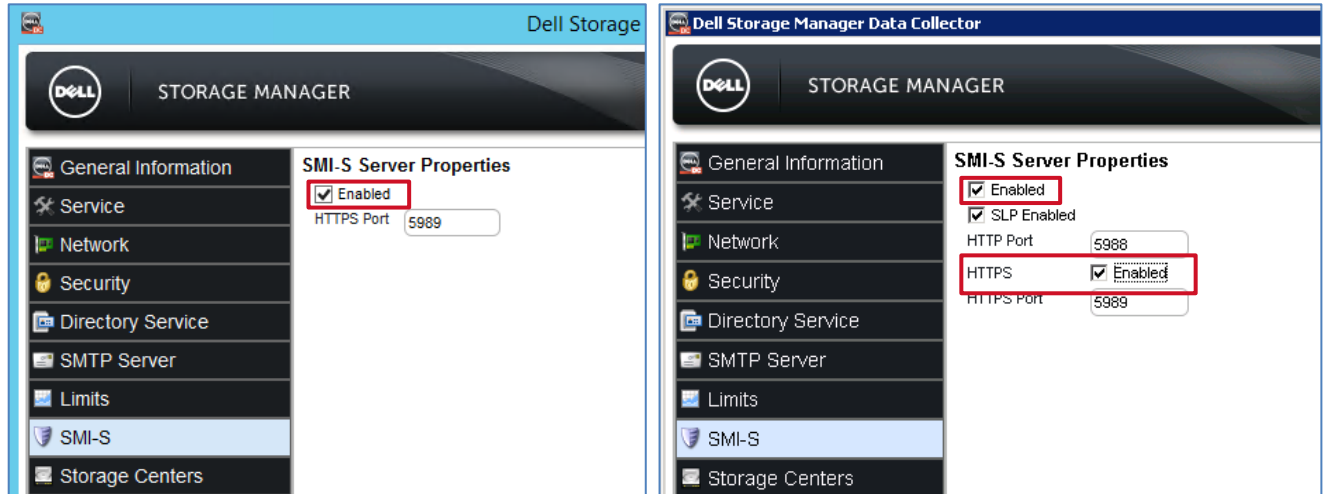
**Note:** For best results with SMI-S integration, upgrade DSM to version 2016 R1 or newer. SCVMM 2016 requires DSM 2016 R3 or newer.

1. Log in to the DSM Data Collector (not the DSM client) as an administrator.



The screenshot shows the login interface for the Dell Storage Manager Data Collector. The window title is "Storage Manager Data Collector" with "Version 2016 R3" below it. A red arrow points to the title. The interface includes a "Display Language" dropdown menu set to "English", a "User Name" field containing "mglasser", and a "Password" field with masked characters. A "Remember Password" checkbox is checked. At the bottom right, there are "Cancel" and "Log In" buttons.

2. In the left navigation pane, click **SMI-S** and enable **SMI-S Server**. For versions of DSM prior to 2016 R3 (see the following example on the right), also enable HTTPS. If storage discovery fails, enabling **SLP** (optional) may aid with storage discovery. If the default ports are changed, configure the local server firewall to allow them.



3. When finished, click **Apply Changes**. If prompted, click **Yes** to restart the Data Collector service.

## 5 Create SMI-S user accounts

Before SCVMM can discover and manage SC Series storage, an SMI-S user account must be created in two places: on the Data Collector and also in SCVMM (as a Run As account).

In this guide, the both user instances are intuitively named as **smis**. The user name is case sensitive and the passwords must be consistent.

**Note:** DSM 2016 R3 is featured in this guide. Data Collector versions prior to DSM 2016 R1 require extra configuration steps (automated with PowerShell). See appendix B for details.

### 5.1 Create SMI-S user in DSM

1. Log in to the DSM Data Collector (not the DSM client) as an administrator.
2. In the left navigation pane, click **Users and User Groups**, and click **Create User**.
3. Provide a user name and password. In this example, the user is named **smis** (user name is case sensitive). Set the privilege level to **Administrator**. When finished, click **Next**.

Dell Storage Manager Data Collector

STORAGE MANAGER

**User Settings**

User Name: smis

Email Address:

Privilege: Administrator

Preferred Language: English (US)

New Password:

Confirm Password:

Requires Password Change: ☐ Enabled

4. Verify that the new user is listed with administrator privileges.

Dell Storage Manager Data Collector

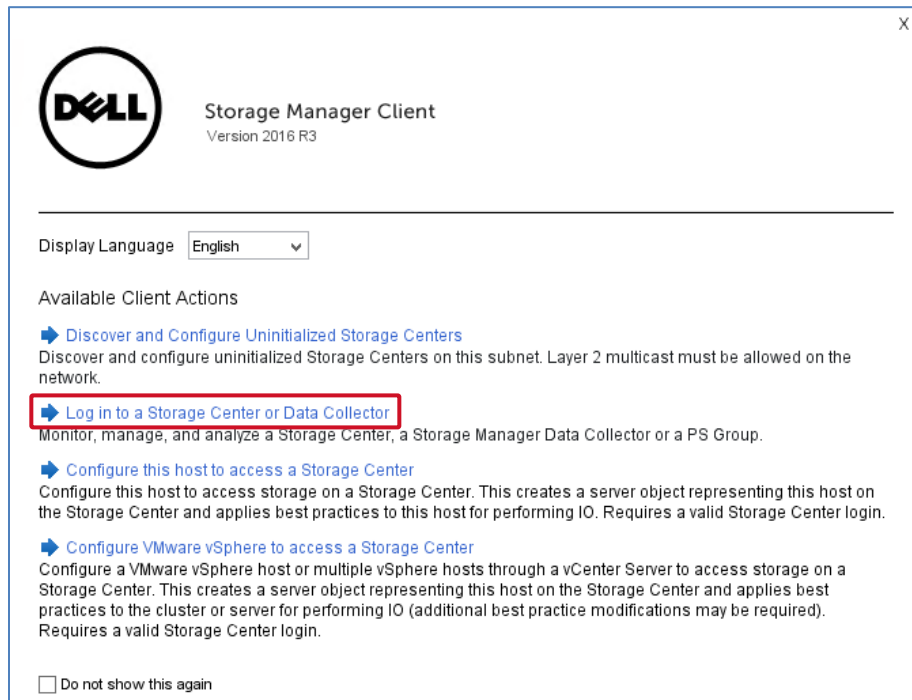
STORAGE MANAGER

General Information | Service | Network | Security | Directory Service | SMTP Server

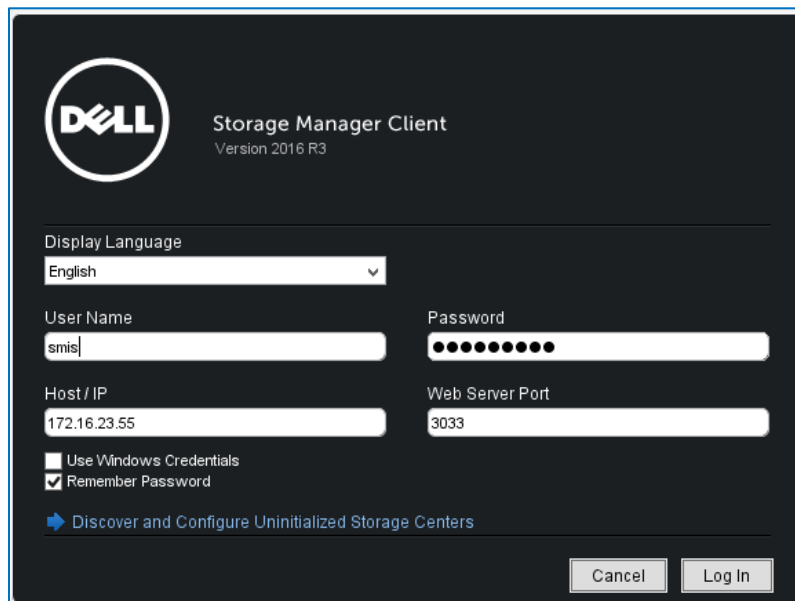
Users | User Groups

User Name	Privilege	Preferred Language
smis	Administrator	English (US)

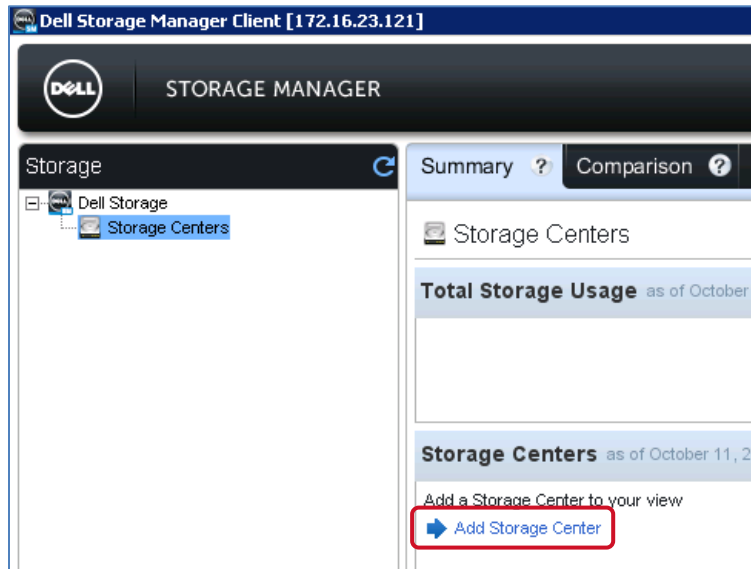
5. Launch the DSM client, and under **Available Client Actions**, select **Log in to a Storage Center or Data Collector**.



6. Enter the **smis** user credentials and the host name or IP address of the server hosting the Data Collector.



7. As a newly created user, the **smis** user will not have access to any SC Series arrays, so at least one array needs to be added that can be discovered and managed by SCVMM. An SC Series array named **SC17** is used in this example.
8. Under the **Summary** tab, click **Add Storage Center**.

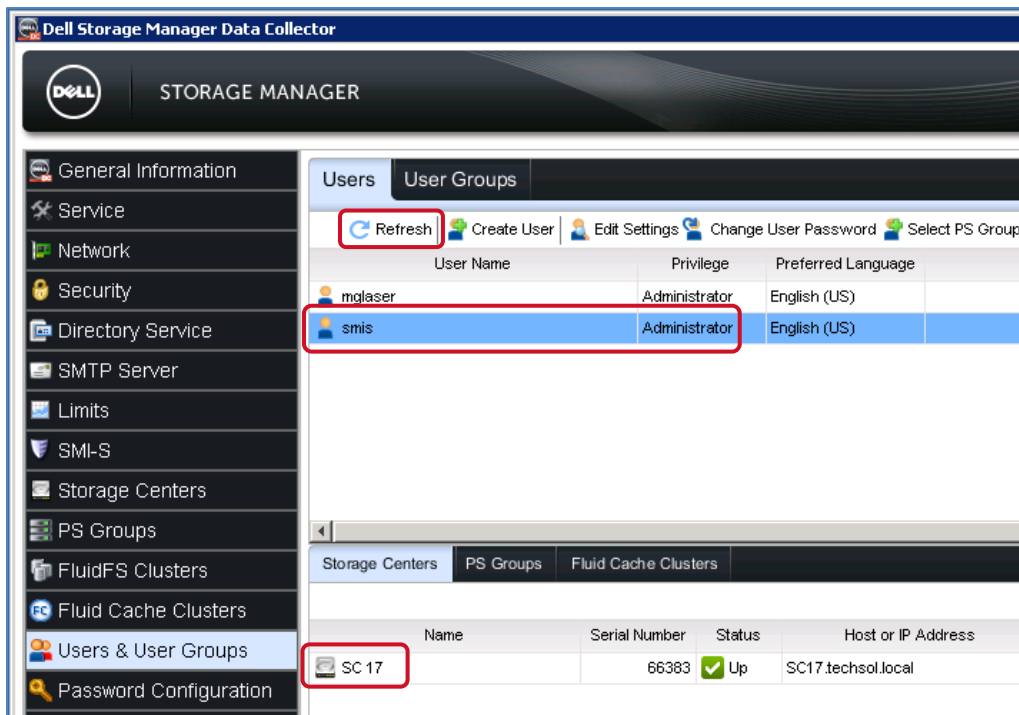


9. Provide the hostname (or IP address), user name, and password for the desired SC Series array. The SC Series user account must have administrator rights to the SC Series array.

**Note:** Add one SC Series array at a time for best results with SC Series discovery in SCVMM.

The screenshot shows the 'Add Storage Center' dialog box. It has a title bar 'Add Storage Center'. Inside, there is a section 'Provide login information for Storage Center' with three input fields: 'Hostname or IP Address\*' with the value 'sc17.techsol.local', 'User Name' with the value 'admin', and 'Password' with the value '\*\*\*\*\*'. Below these fields is a note: '\*For Dual-Controller Storage Center, enter Management IP Address or Hostname'. At the bottom, there is a 'Folder' label and a dropdown menu showing 'Storage Centers'.

- After adding the SC Series array, close the DSM client and return to the DSM Data Collector. **Under Users & User Groups, click Refresh.** The SC Series array should now be listed under Storage Centers for the **smis** user.



- Close the DSM Data Collector when finished.

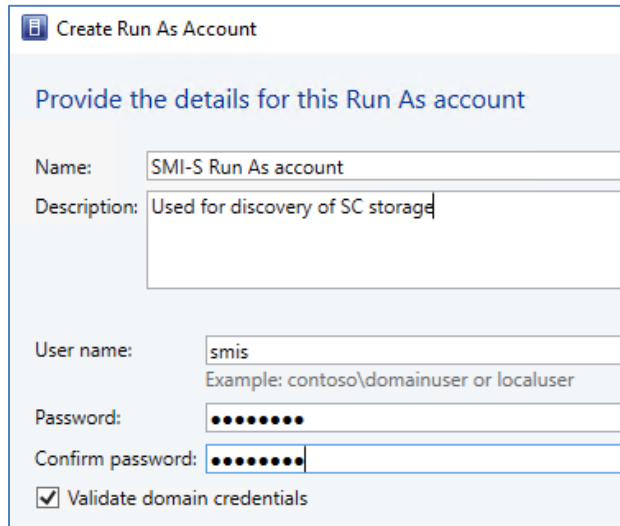
## 5.2 Create SMI-S Run As account in SCVMM

A matching SMI-S Run As account must be configured on the SCVMM server in order to do storage discovery. To be consistent, the Run As account is named **smis** and uses the same password as the **smis** user configured on the Data Collector.

- Log on to the SCVMM Administrator Console as an administrator user.
- In the left navigation pane, click **Settings > Run As Accounts** to see a current list.
- Click **Create Run As Account** on the ribbon bar.



4. Provide a name, description, user name (**smis** in this example), and password, and click **Finish**.



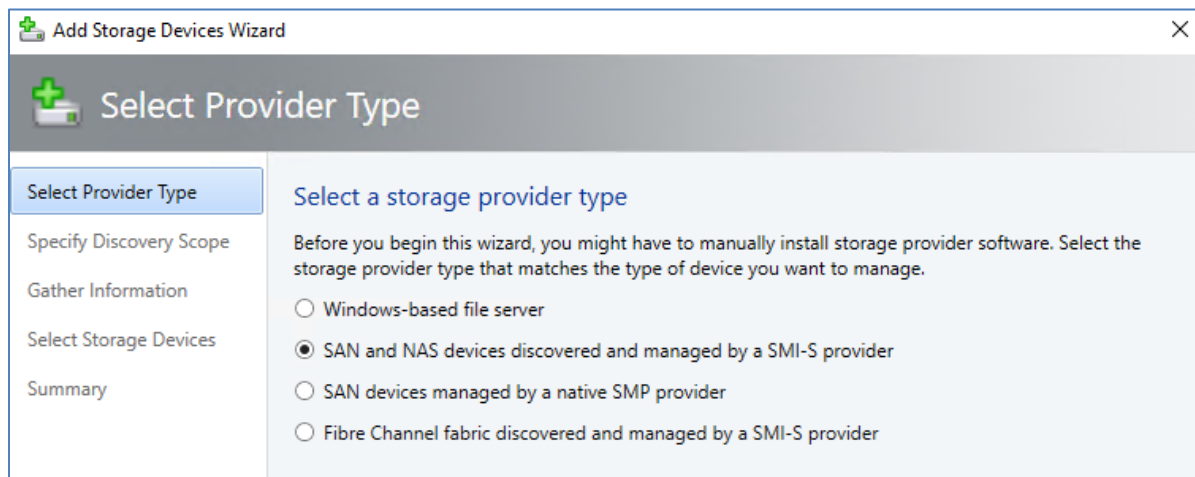
The screenshot shows a 'Create Run As Account' dialog box with the following fields and options:

- Name:** SMI-S Run As account
- Description:** Used for discovery of SC storage
- User name:** smis  
Example: contoso\domainuser or localuser
- Password:** [masked with dots]
- Confirm password:** [masked with dots]
- ☒ **Validate domain credentials**

## 6 Discover SC Series storage in SCVMM

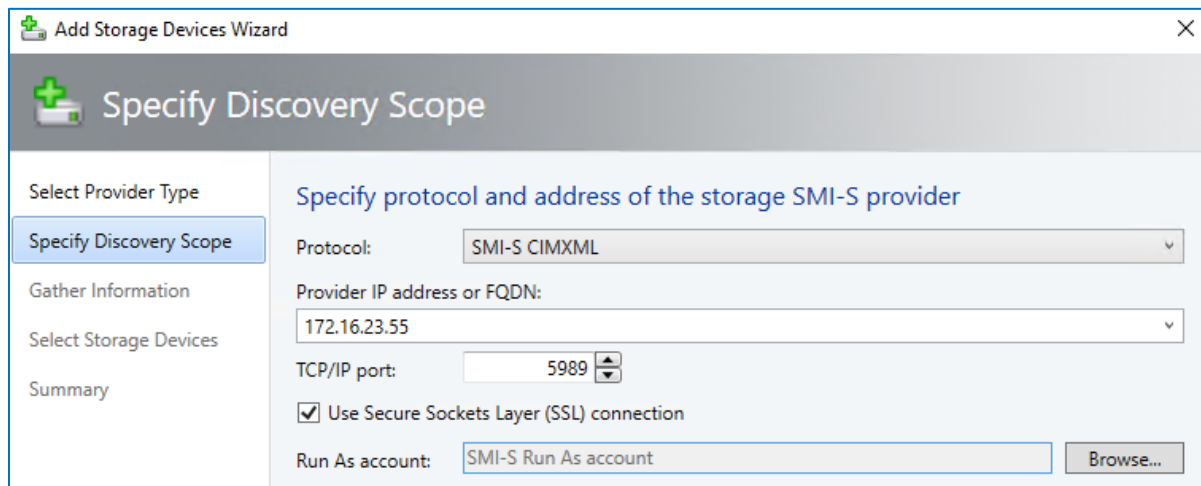
In this section, SCVMM is used to discover and manage an SC Series array named **SC17**. The steps in the preceding sections must be completed before attempting discovery.

1. Log in to the SCVMM Administrator Console as an administrator user.
2. In the left navigation pane, click the **Fabric** workspace.
3. Expand **Storage**, right-click **Providers**, and click **Add Storage Devices** to start the **Add Storage Devices Wizard**.
4. For the provider type, select **SAN and NAS devices discovered and managed by a SMI-S provider** and click **Next**.



The screenshot shows the 'Add Storage Devices Wizard' window. The title bar says 'Add Storage Devices Wizard'. The main heading is 'Select Provider Type'. On the left, there is a navigation pane with four items: 'Select Provider Type' (highlighted), 'Specify Discovery Scope', 'Gather Information', 'Select Storage Devices', and 'Summary'. The main content area has the heading 'Select a storage provider type' and a sub-heading 'Before you begin this wizard, you might have to manually install storage provider software. Select the storage provider type that matches the type of device you want to manage.' There are four radio button options: 'Windows-based file server', 'SAN and NAS devices discovered and managed by a SMI-S provider' (which is selected), 'SAN devices managed by a native SMP provider', and 'Fibre Channel fabric discovered and managed by a SMI-S provider'.

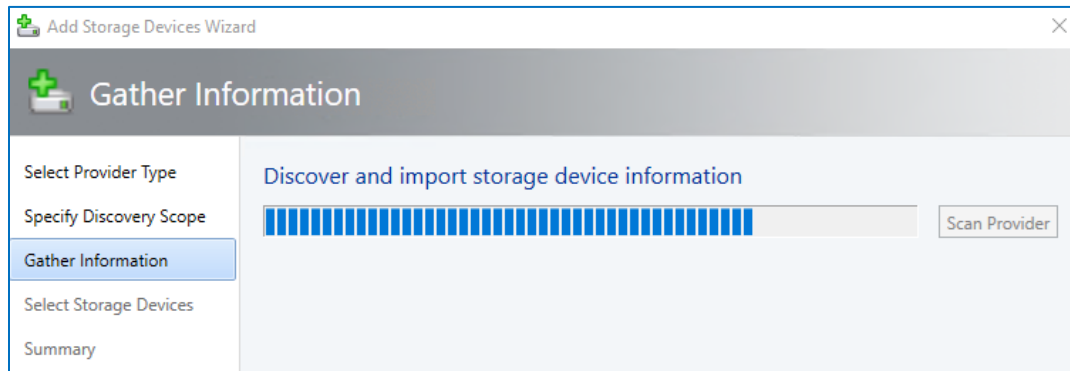
5. For the discovery scope, set the Protocol to **SMI-S CIMXML**, provide the IP address of the Data Collector server (not the SC Series array), enable SSL, click **Browse**, select the **SMI-S Run As account**, and click **Next**.



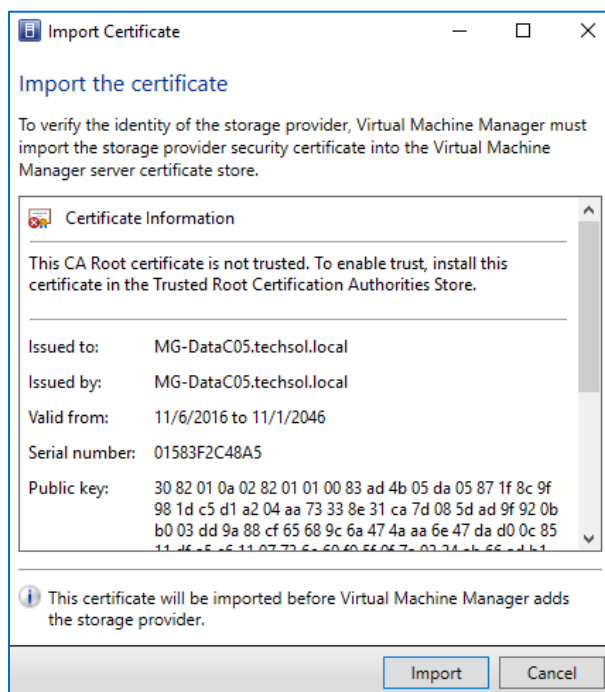
The screenshot shows the 'Add Storage Devices Wizard' window. The title bar says 'Add Storage Devices Wizard'. The main heading is 'Specify Discovery Scope'. On the left, there is a navigation pane with four items: 'Select Provider Type', 'Specify Discovery Scope' (highlighted), 'Gather Information', 'Select Storage Devices', and 'Summary'. The main content area has the heading 'Specify protocol and address of the storage SMI-S provider'. There are four input fields: 'Protocol' (a dropdown menu with 'SMI-S CIMXML' selected), 'Provider IP address or FQDN' (a text box with '172.16.23.55' entered), 'TCP/IP port' (a spinner box with '5989' selected), and 'Run As account' (a text box with 'SMI-S Run As account' entered). There is a checkbox labeled 'Use Secure Sockets Layer (SSL) connection' which is checked. There is a 'Browse...' button next to the 'Run As account' field.

- The wizard displays a storage discovery progress bar as it discovers the SC Series array associated with the **smis** user configured on the Data Collector server. This may require a few minutes to complete.

**Note:** If storage discovery fails, see appendix B for troubleshooting guidance.



- If prompted to import a security certificate, click **Import** and allow the discovery to continue.



8. Once the discovery completes, a storage device is displayed. In this example, **SC17** is the discovered storage device. Click **Next** to continue.

**Add Storage Devices Wizard**

**Gather Information**

Select Provider Type

Specify Discovery Scope

**Gather Information**

Select Storage Devices

Summary

Discover and import storage device information

Scan Provider

Storage Device	Manufacturer	Model	Capacity
SC 17	DELL	Storage Center Sc8000Series	39,122.39 GB

9. Under **Select Storage Devices**, click the **Create classification** button and create a classification for the SC Series array if the desired classification does not already exist. A classification is a means for providing descriptive information about the array, such as location, purpose, or capacity. In this example, the classification name is set to **SC17**, the same as the array name.
10. After creating a classification, select the storage array by enabling the checkbox. Under the **Classification** column, click the down arrow to select the desired classification for the SC Series array. Under the **Host Group** column, click the drop-down arrow and choose the desired SCVMM host group. Click **Next**.

**Add Storage Devices Wizard**

**Select Storage Devices**

Select Provider Type

Specify Discovery Scope

Gather Information

**Select Storage Devices**

Summary

Select storage devices

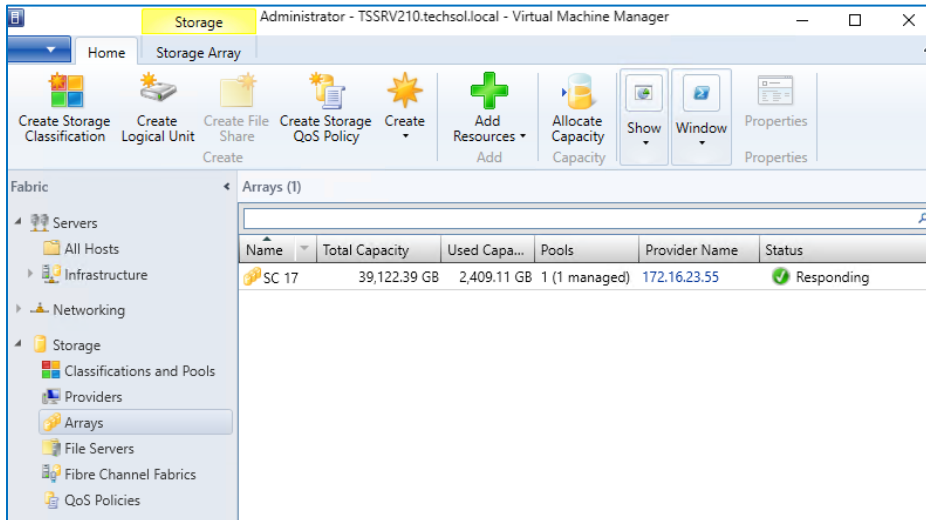
Select the storage pools you want to manage and assign a storage classification. Logical unit (LUN) information will be imported from the storage pools. You can create classifications if required.

Storage Device	Pool ID	Total Capacity	Classification	Host Group
SC 17		39,122.39 GB		
<input checked="" type="checkbox"/> Assigned	sc17:Assigned	39,122.39 GB	SC17	All Hosts

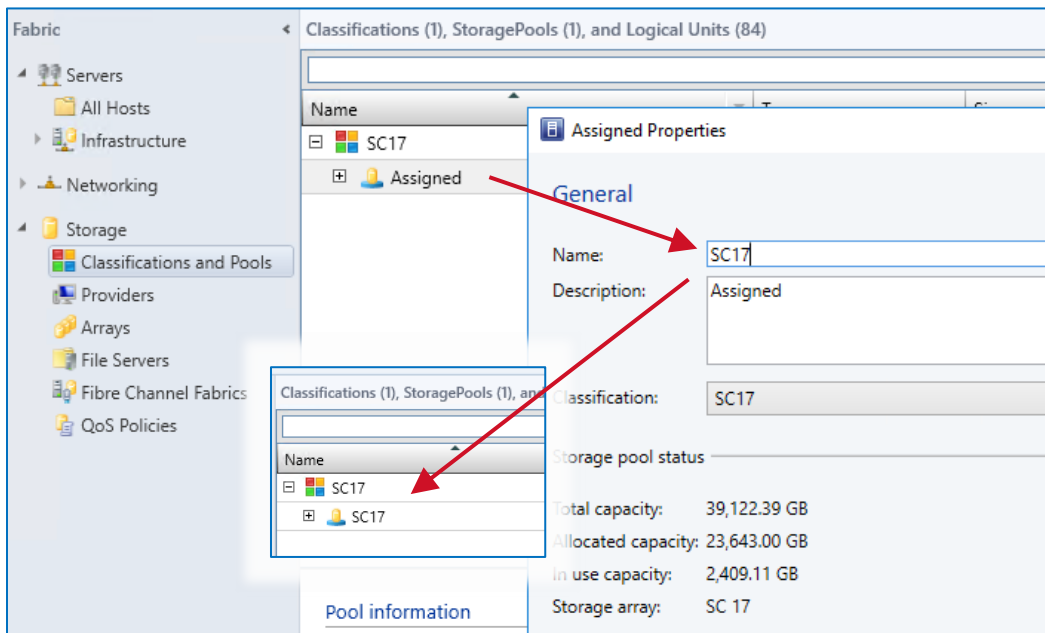
11. Review the settings on the **Summary** screen and click **Finish**.
12. Monitor the status of the **Sets Storage Provider** job in SCVMM until it completes.

13. In the SCVMM fabric, each of these locations under **Storage** should now display information about the SC Series array, with a status of **Responding**:

- Arrays
- Providers
- Classifications and Pools



14. Optionally, click **Classifications and Pools**, and change the name for the storage pool from **Assigned** so that it matches the array name and classification name. In this example, the name of the storage pool is changed to **SC17** so that the name for the array, the classification, and storage pool are consistent. This is helpful if additional SC Series arrays are to be managed by the same instance of SCVMM.



15. Expand the **Storage Pool** tree. Any existing volumes on the SC Series array (identified as logical units in SCVMM) are displayed below the storage pool.

Classifications (1), StoragePools (1), and Logical Units (84)	
Name	Type
SC17	Classification
SC17	Storage pool
Dell_R610_2012_Gold_Image	Logical unit
KP_TSSRV303_W12DC_R2_VL_2015-10-1...	Logical unit
KP_TSSRV304_W12DC_R2_VL_2015-10-1...	Logical unit
MG_Dell_R320_G12_W12DC_FC_Gold_B...	Logical unit

16. Storage discovery in SCVMM is now complete.
17. To add additional SC Series arrays to SCVMM, see section 6.1.

## 6.1 Discover additional SC Series arrays

For best results, discover SC Series arrays with SCVMM one at a time. After successfully adding an SC Series array, to add additional arrays, complete the following steps:

1. Log in to the DSM client as the **smis** user and assign an additional SC Series array to this user (see section 5).
2. Under **Fabric > Storage > Providers** in SCVMM, right-click the storage provider (listed by IP address in this example) and select **Rescan**.
3. Monitor the **Reads Storage Provider** job until it completes successfully. This may take several minutes.
4. Once the additional SC Series array has been discovered, it is listed under **Fabric > Storage > Arrays**. Right-click the new SC Series array and select **Properties > Storage Pools**.
5. Under the **Storage Pools** tab, click the **Create Classification** button to create a new classification for the SC Series array. If the desired classification already exists, choose it from the **Classification** drop-down list. Assign a **Host Group** and click **OK**.
6. Under the **Jobs** workspace, verify that the **Sets Storage Array** job completes successfully.
7. Once the job completes, go to **Fabric > Storage > Classifications and Pools**. The newly discovered SC Series array should now be listed with a storage pool below it.
8. If desired, change the storage pool name from **Assigned** to something more descriptive. This is recommended if managing more than one SC Series array.

## 7 Configure other SCVMM fabric components

For purposes of this guide, a basic SCVMM fabric is configured that will support SAN copy-capable templates for rapid provisioning, along with other basic SAN management functions.

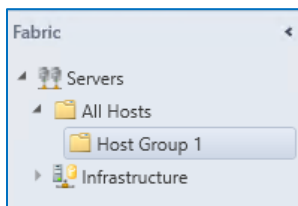
The preceding sections show how to configure the SAN storage component of the SCVMM fabric. Other fabric components must also be configured and each is briefly described in this section. For more information on how to configure SCVMM, visit the [Microsoft TechNet Library](#).

**Note:** It is often necessary to perform extra steps to assign rights and permissions to new objects in SCVMM to avoid access denied errors and job failures.

### 7.1 Define a host group structure

A host group allows administrators to group physical host servers logically according to identifiers as location, level of redundancy, type of hosted application, type of hypervisor, or business unit.

In this document, a host group named **Host Group 1** is configured in SCVMM.



### 7.2 Configure a library server

A library server provides a way to define a catalog of resources that are available for deploying and configuring both host and guest VM servers. Many kinds of common file types (as well as custom install packages) and templates can be added to a library server.

Table 2 Library server resources

Types of library server resources		Details
File-based	Automatically indexed file types: files which are indexed and added automatically during library server refreshes in SCVMM	Includes many common file types such as virtual hard disks, ISOs, PowerShell scripts, and driver files
	Custom file types (folders with .CR extension)	Might include a custom installation package
Non-file-based		Templates and profiles (stored in the SCVMM database) that are used to automate host and guest deployments

As shown in Table 2, many types of resources can be added to a library server. By default, the SCVMM server installation creates a local instance of a library server on that same server. For larger

environments, this can be changed so that the library server is on a separate server. SCVMM also supports multiple library server instances.

The default location for the library server resources (which is a shared folder) is:

```
C:\ProgramData\Virtual Machine Manager Library Files
```

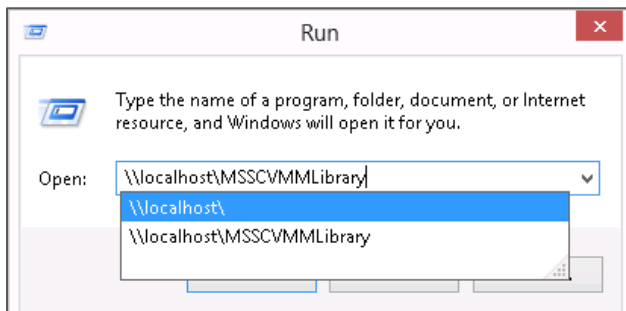
It is a best practice to change this path to a data volume during SCVMM installation so that the library server share it is not located on the same volume as the OS. In the examples shown in this document, the path is changed to a data volume assigned to the host server as the D:\ drive.

### 7.2.1 Copy resources to a library server

If the default share path is chosen during the library server installation, because the **C:\ProgramData** folder is a hidden folder by default, it is not possible to use Windows Explorer to navigate directly to the share location without first removing the hidden attribute on the ProgramData folder (not recommended). The suggested way to copy resources to the library server share is to access the folder by its share name.

1. On the server where the library server role is installed, open a **Run** window and in the **Open** field, type the following path:

```
\\localhost\MSSCVMMLibrary [enter]
```

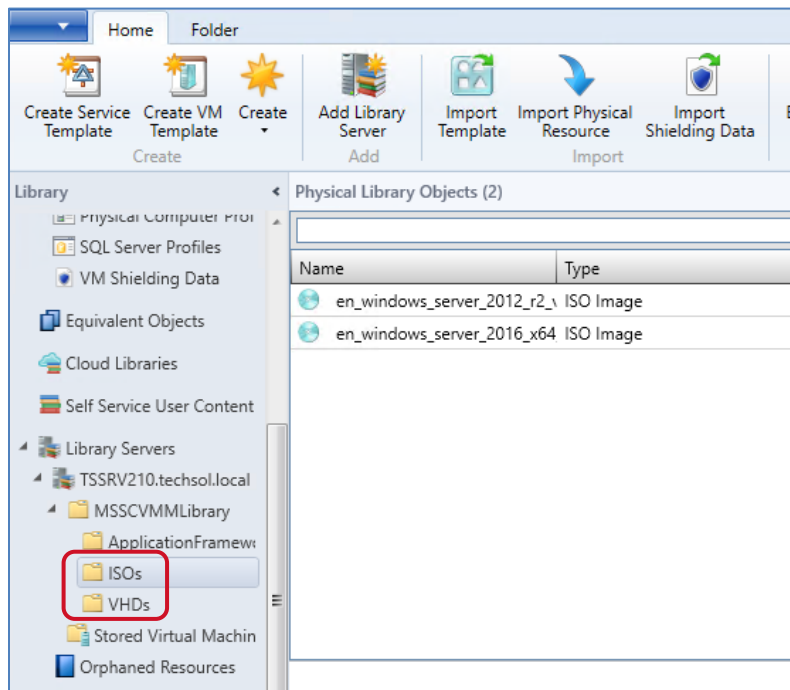


**Note:** To access the library server share from another computer, instead of localhost, use the library server's host name or IP address. For example:

```
\\172.16.23.30\MSSCVMMLibrary [enter]
```



- Files and other resources must be copied to the library server's share manually outside of SCVMM. To do this, use Windows Explorer to create one more subfolders to logically group similar file types, such as ISOs or virtual hard disks under this share. Then, copy the desired file resources to these subfolders. In this document, folders named **ISOs** and **VHDs** are created as locations for ISO and virtual hard disks files for deploying new VMs.

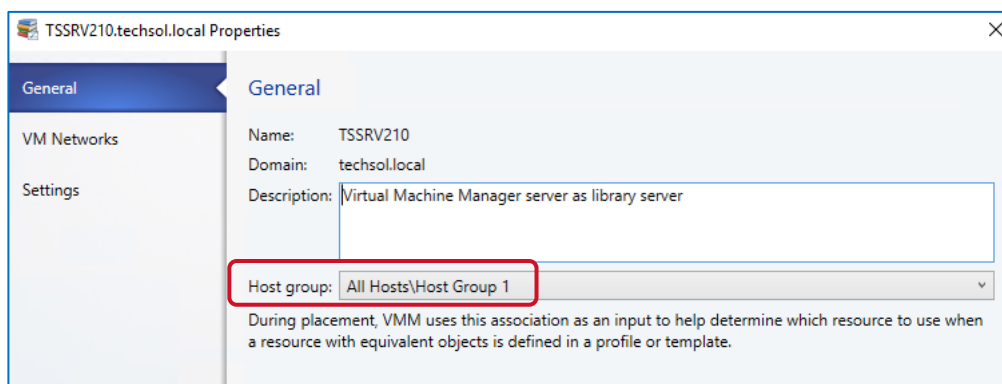


- Once resources have been copied to subfolders under the library server's share, return to the SCVMM console, and manually refresh the library server to view the new folders and files. To manually refresh the library server, right-click the library server object in SCVMM and select **Refresh** (automatic refreshes occur hourly by default).
- After the manual refresh job completes (monitor the status under the **Jobs** view), expand the **Library Servers** tree to verify that the added folders files and resources are now available.

## 7.2.2 Assign a library server to a host group

After a library server has been configured, it needs to be assigned to a server host group. This will allow the physical Hyper-V host servers that are currently assigned to that host group (or that will be assigned to that host group later on) to access to the library server's resources.

1. To assign a library server to a host group, right-click the library server and select **Properties**.
2. Under the **General** tab, make sure that a host group is assigned. In this example, the library server is assigned to the host group named **Host Group 1**.



## 7.3 Add physical Hyper-V host servers to SCVMM

In this guide, several Hyper-V servers with Fibre Channel access to SC17 are added to SCVMM as targets for VM placement. These servers also serve as eligible targets for rapidly provisioned guest VMs.

### 7.3.1 Verify consistent and intuitive naming for host server virtual switches

Before adding existing physical Hyper-V hosts or clusters to SCVMM, it is a best practice to ensure that consistent and intuitive naming is in place for the virtual switch and cluster network components on each host. This will:

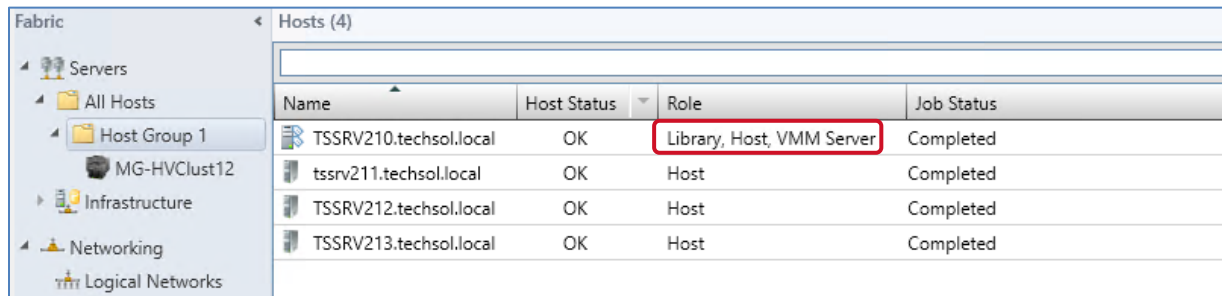
- Make management easier due to intuitive naming
- Ensure that Hyper-V network components for failover clusters are classified as highly available by SCVMM
- Make it easier to add a standalone Hyper-V server to a cluster using SCVMM

### 7.3.2 Add Hyper-V hosts and clusters to SCVMM

In this guide, SCVMM is configured to manage four Hyper-V servers. All four servers are assigned to **Host Group 1**:

- **TSSRV210**: Windows Server 2016 with Desktop Experience (SCVMM 2016, library server, Hyper-V 2016)
- **TSSRV211**: Windows Server 2012 R2 Hyper-V (standalone host)
- **TSSRV212** and **TSSRV213**: Windows Server 2012 R2 Hyper-V (two-node cluster)

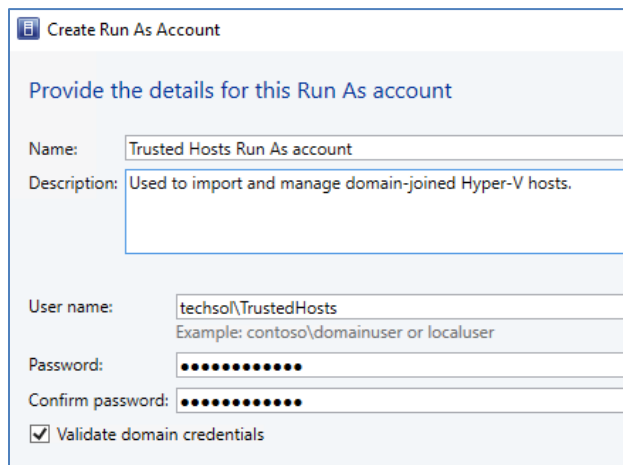
**Note:** In order to support rapid provisioning, the library server must be installed on a physical Hyper-V host that is (1) managed by SCVMM and (2) has access to the managed SC Series array used for rapid provisioning. In this example, the server **TSSRV210** hosts all three roles: Hyper-V, SCVMM, and library server.



Name	Host Status	Role	Job Status
TSSRV210.techsol.local	OK	Library, Host, VMM Server	Completed
tssrv211.techsol.local	OK	Host	Completed
TSSRV212.techsol.local	OK	Host	Completed
TSSRV213.techsol.local	OK	Host	Completed

In this example, all servers are members of the same AD domain.

**Tip:** Create a Run As account in SCVMM to manage domain-joined Hyper-V servers.



**Create Run As Account**

Provide the details for this Run As account

Name: Trusted Hosts Run As account

Description: Used to import and manage domain-joined Hyper-V hosts.

User name: techsol\TrustedHosts  
Example: contoso\domainuser or localuser

Password: [Masked]

Confirm password: [Masked]

☒ Validate domain credentials

After adding Hyper-V servers to SCVMM, verify the placement paths for VMs by viewing the host properties. Placement paths should avoid using the OS volume on standalone Hyper-V hosts. The placement path on Hyper-V clusters should default to a cluster storage location automatically.

### 7.3.3 Configure networking in SCVMM

SCVMM global network configuration settings are configured by default to automatically create and assign logical networks and network sites to new server hosts and guests when they are managed by SCVMM. This ensures basic functionality out of the box when DHCP is in place and dynamically assigned IPs are used for Hyper-V hosts or guests.

If desired, these default global networking configuration settings can be modified as needed, for example, to specify a smaller block of static IPs within a subnet as a designated pool for SCVMM to draw from when new IPs are assigned to new guest VMs.

When existing Hyper-V hosts are added to SCVMM for management, the network configuration information for these hosts is also discovered and added to SCVMM.

In this example, because the time was taken in advance to ensure that the virtual switches on each host were all named consistently before adding the hosts to SCVMM, there are two common virtual switches (logical networks) for all hosts listed in SCVMM.

Logical Networks and IP Pools (2)	
Name	Network Compliance
vSwitch1_LAN	Fully compliant
vSwitch2_Cluster	Fully compliant

If IP pools are desired, they can be easily defined and associated with each logical network. To create and assign an IP pool to a logical network, click the desired logical network to highlight it, and from the ribbon, select **Create IP Pool** to launch the **Create Static IP Address Wizard**. IP pools are not used in the configuration examples shown in this guide.

**Note:** For more information on how to configure and manage networking and IP address pools, visit the [Microsoft TechNet Library](#).

## 7.4 Allocate a storage pool to a host group

Verify that the SC Series array (defined as a storage pool in SCVMM) is assigned to the desired SCVMM host group. If a host group was specified at the time the SC Series array was discovered, this storage allocation should already be in place.

1. In SCVMM, go to **Fabric > Storage** and on the ribbon, click **Allocate Capacity**.
2. Verify that the SC Series array is allocated to the desired host group. If not, then assign it. In this example, **SC17** is assigned to **Host Group 1**.

Allocated storage for this host group			
Logical units		Allocate Storage Pools...	
Number of logical units: 0		Allocate Logical Units...	
Total capacity: 0 GB			
Available capacity: 0 GB			
Storage pools:			
Name	Classification	Total Capacity	Description
SC17	SC17	39,122.39 GB	Assigned

## 8 SCVMM profiles and templates

Leveraging predefined profiles and templates is a convenient way to ensure consistent VM deployments, including rapid provisioning.

### 8.1 Profiles

To create hardware and OS provides in SCVMM, go to **Library > Profiles**. Right-click the desired profile option and select **Create** to launch the wizard. Create as many different hardware and OS profiles as needed to support the types of guest VMs that will be deployed.

In this example, basic hardware and guest OS profiles are used for demonstrating basic SCVMM functionality and rapid provisioning.

### 8.2 Templates

Profiles become the building blocks to create VM deployment templates. A VM template consists of a hardware profile and a guest OS profile that together provide the necessary parameters to automate and streamline the process of provisioning a new guest VM.

### 8.3 Network copy and SAN copy-capable templates

With SCVMM, two types of VM templates can be created: network copy templates and SAN copy-capable templates.

#### 8.3.1 Network copy templates

With a network copy VM template, full copies of the source files (including the virtual hard disks) are deployed from the library server to the target host each time a new VM guest provisioned. There are a few considerations to be aware of when using network copy VM templates:

- By default, SCVMM will attempt to use offloaded data transfer (ODX) to perform a fast copy assuming that all of the components in the environment support ODX. For example, SCOS must be 6.3.1 or newer, and the source and destination volumes must be NTFS volumes. Leveraging ODX can shorten the copy time for large source files significantly.

**Note:** See the [Windows Server Best Practices Guide](#) on Dell TechCenter for more information on ODX.

- If for any reason SCVMM is unable to perform an ODX transfer, SCVMM will default to a regular Windows file copy to deploy the files needed for the VM over the network. Copying virtual hard disk files over the network may require significantly more time than an ODX copy and may negatively impact available network bandwidth. These considerations may limit when and where new VMs can be deployed, especially if there is a low-bandwidth connection between the library server and the target host.

- Regardless of the data transfer method (ODX or non-ODX), no space savings are realized on the SAN because duplicate copies of files needed are copied from the library server to the target server each time a new VM is deployed.

### 8.3.2 SAN copy-capable templates

With SAN copy-capable VM templates, SCVMM leverages the SC Series SMI-S provider to deploy new guest VMs from a gold image volume on the SAN. This is known as rapid provisioning and provides the following benefits:

- There is minimal impact to network bandwidth because full copies of virtual hard disks do not need to be copied over the network when deploying a new guest VM.
- Deployment of new guest VMs is much quicker due to not having to wait for large virtual hard disk files to transfer from the library server to the target host.
- Due to leveraging a gold image source, no SAN space is wasted due to deployment of duplicate virtual hard disk files for each new guest VM deployed. Because many new guest VMs can be provisioned from the same gold image source volume, this results in significant space savings on the SAN.

**Note:** Factors such as the I/O demand of the workload will determine the functional limit of the number of guest VMs that can be deployed from the same gold image.

## 9 Create a SAN copy-capable template from a gold image

Creating a SAN copy-capable template for rapid provisioning of new guest VMs is similar to creating a network copy template. A few extra steps are required.

### 9.1 Choose a method for creating a SAN copy-capable template

There are a couple of options for selecting a source guest VM when creating a SAN copy-capable template. This assumes that the prerequisites are in place to support this feature as described previously. For example, the SCVMM library server must be installed on a physical host that has the Hyper-V role installed.

**Option 1:** Create a template from a new guest VM that is built from scratch using a blank virtual hard disk and is patched, customized, powered down, cloned, and then imported into the library server. The import process destroys the source guest, and it is sysprepped it as part of creating the template. Cloning the guest VM beforehand preserves the original guest image for later use.

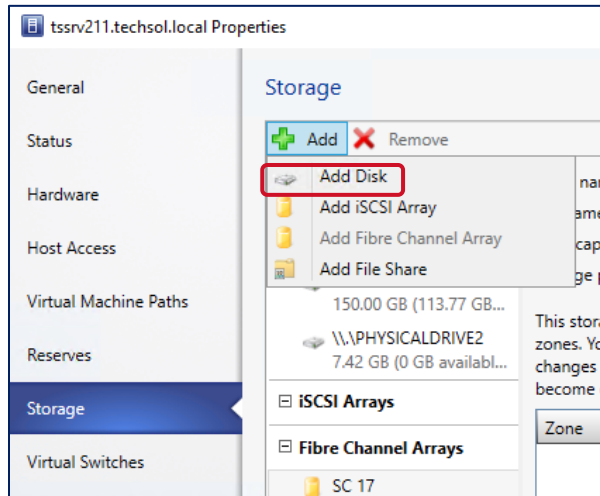
**Option 2:** Create a template from an existing guest VM on a managed Hyper-V host. This process is also destructive to the source guest VM, so it should be cloned first if the original image will be needed later.

In the following example, the step-by step instructions are shown for configuring a SAN copy-capable template for rapid provisioning using option 1.

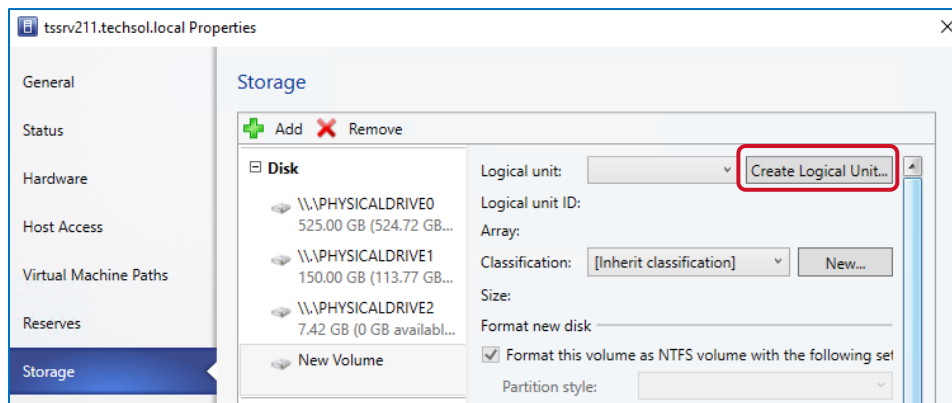
### 9.2 Create a logical unit and assign it to a Hyper-V host

1. Decide which Hyper-V host server to use for staging the new guest VM. This Hyper-V server must have access to the SC Series array managed by SCVMM. In this example, the standalone Hyper-V host **TSSRV211** is used.

2. Create and assign a new SAN volume (logical unit) to this host server by completing the following steps:
  - a. In SCVMM under **Fabric > Servers > All Hosts**, locate the desired Hyper-V host server.
  - b. Right-click the host (**TSSRV211** in this example) and select **Properties**.
  - c. Click the **Storage** tab.
  - d. Click **Add** and select **Add Disk** (the transport used is Fibre Channel in this example).

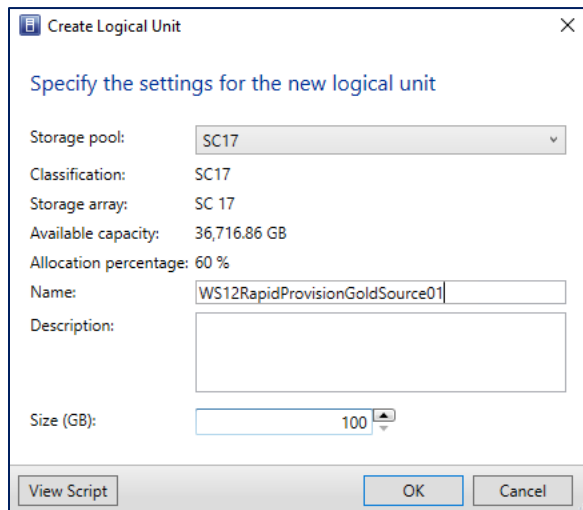


- e. Click **Create Logical Unit**.





- f. Select the desired storage pool from the drop-down list if not already selected (**SC17** in this example), provide a descriptive name (special characters not supported), and specify a LUN size in GB. Click **OK**.



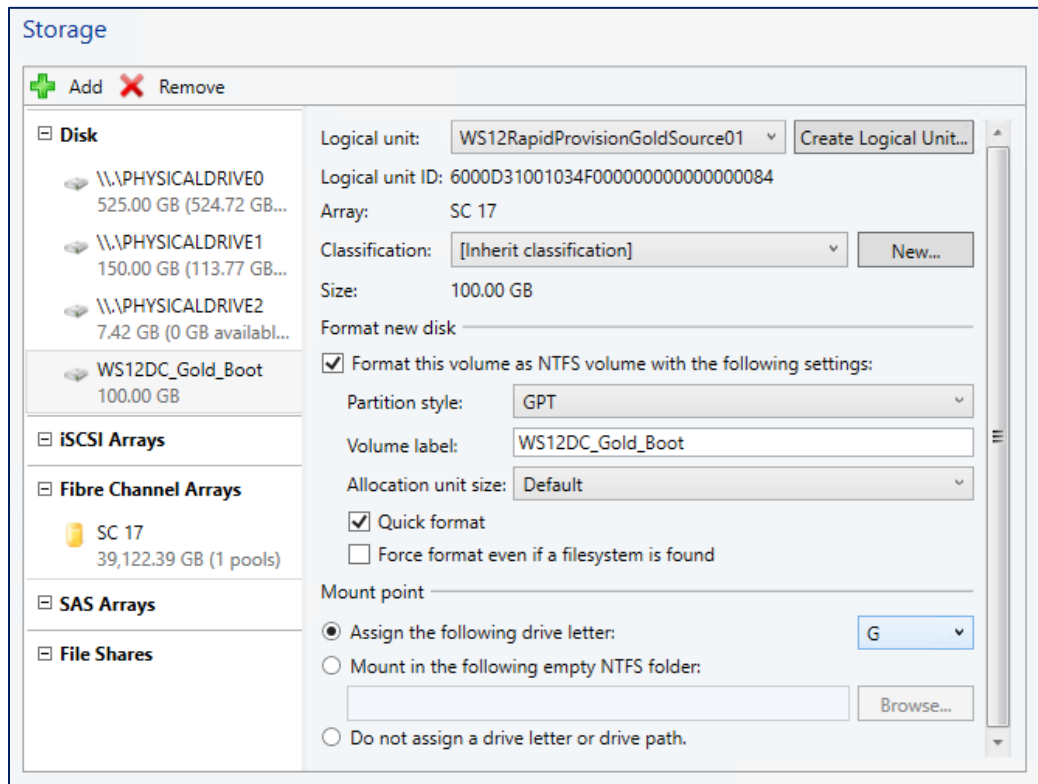
The image shows a 'Create Logical Unit' dialog box with the following fields and values:

- Storage pool:** SC17 (selected in a dropdown menu)
- Classification:** SC17
- Storage array:** SC 17
- Available capacity:** 36,716.86 GB
- Allocation percentage:** 60 %
- Name:** WS12RapidProvisionGoldSource01
- Description:** (empty text box)
- Size (GB):** 100 (selected in a spinner box)

At the bottom, there are three buttons: 'View Script', 'OK', and 'Cancel'.

**Note:** Specify a LUN size with enough capacity for the new virtual hard disk file and the ISO file that will be used to stage the OS. In this example, a 100 GB LUN will allow for an 80 GB virtual hard disk and a 5 GB ISO with some room left over.

3. Format the new LUN with the following settings:
  - a. Format the volume as **NTFS** (the default).
  - b. Provide a descriptive **volume label** (recommended).
  - c. Assign a free **drive letter** to the volume (mount points are not supported when creating a SAN copy capable template). The **G:\** drive is used in this example.
  - d. Click **OK**.

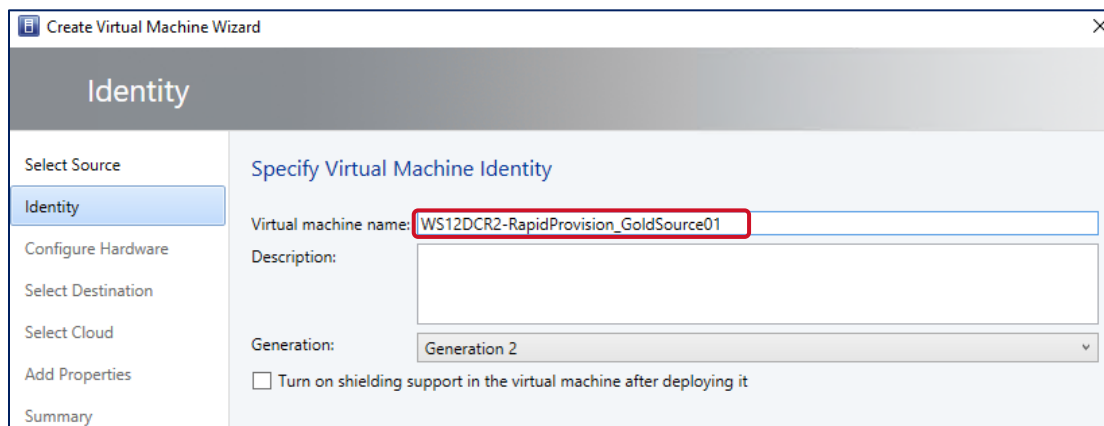


4. In the **Jobs** workspace, monitor the **Change Properties of virtual machine host** job until it completes. This job creates the new logical unit, maps it to the target Hyper-V host (using Fibre Channel mappings in this example), formats the volume, and assigns it a drive letter of **G:\**.

## 9.3 Create a new virtual machine on the new volume

Now that the new volume is formatted and mapped to the target host as the **G:\** drive, a Hyper-V guest VM can be staged to a new virtual hard disk file at this location. The steps to do this are as follows:

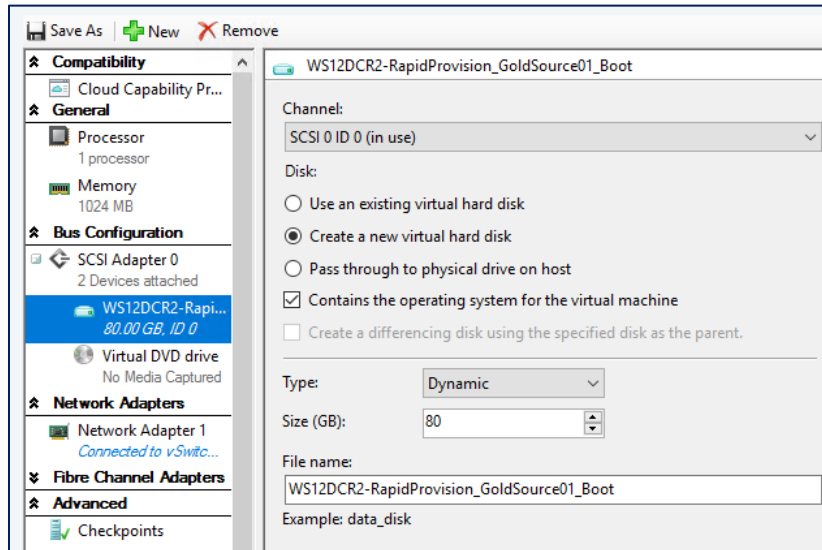
1. From the **VMs and Services** workspace, on the ribbon (under the **Home** tab), click **Create Virtual Machine** to launch the **Create Virtual Machine Wizard**.
2. Under **Select Source**, choose **Create the new virtual machine with a blank virtual hard disk**, and click **Next**.
3. Provide a descriptive VM name, description (if desired), and specify the generation. Since this guest will serve as gold source for rapid provisioning new guest VMs, adding **gold source** to the name is recommended. Click **Next**.



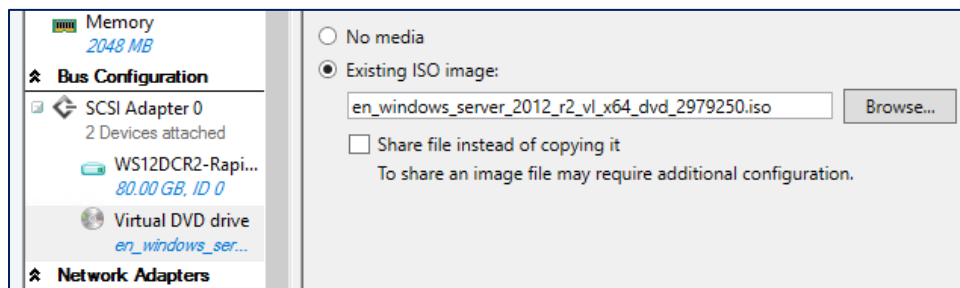
The screenshot shows the 'Create Virtual Machine Wizard' window, specifically the 'Identity' step. The left sidebar contains a list of steps: 'Select Source', 'Identity' (highlighted), 'Configure Hardware', 'Select Destination', 'Select Cloud', 'Add Properties', and 'Summary'. The main area is titled 'Specify Virtual Machine Identity' and contains the following fields:

- Virtual machine name:** A text box containing 'WS12DCR2-RapidProvision\_GoldSource01', which is highlighted with a red rectangle.
- Description:** An empty text box.
- Generation:** A dropdown menu set to 'Generation 2'.
- ☐ Turn on shielding support in the virtual machine after deploying it

4. Under **Configure Hardware**, provide the desired hardware configuration for the VM such as cloud compatibility (set to Hyper-V), processor, memory, and network configuration.
  - a. Under **Bus Configuration**, select the boot virtual hard disk.
  - b. Select **Create a new virtual hard disk**.
  - c. Set the size in GB (**80 GB** in this example). Set the size large enough so that any VMs provisioned from this template will not use up the virtual hard disk space.
  - d. The default virtual hard disk type is **Dynamic**. Change this to **Fixed** if desired.
  - e. Adjust the virtual hard disk file name if desired. In this example, **\_boot** is added to the name of the file to make identifying its purpose more intuitive later on.

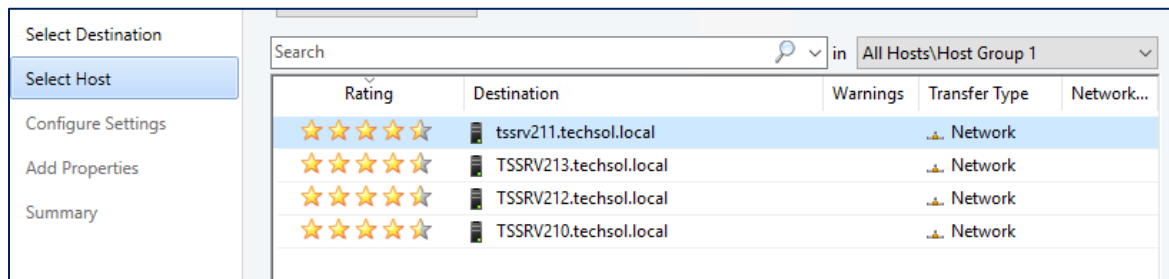


- f. Under **Bus Configuration**, click the **virtual DVD drive**.
  - g. Under **Media**, select the option to use an **Existing ISO image** file.
  - h. Click **Browse** and select (from the library server) an ISO to stage the OS (Windows Server 2012 R2 in this example).
  - i. Leave the **Share image file instead of copying it** option deselected.

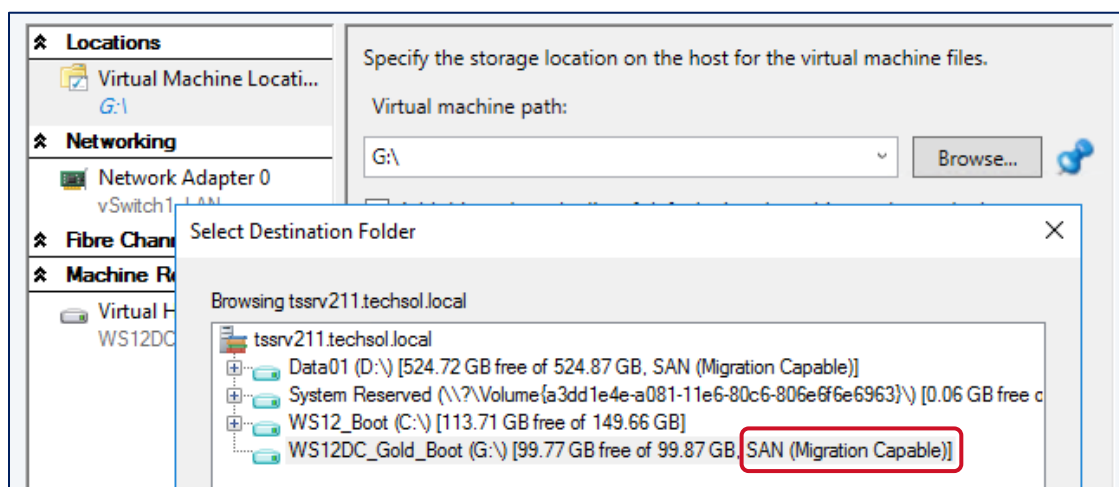


**Note:** Although sharing the ISO is possible (the OS would then be installed over the network), setting up the share requires extra configuration. It is generally preferable to perform a new server OS install from an ISO file (or other media) that is local to the host server. The LUN on the host server is configured with enough extra space so this ISO file can be copied locally on a temporary basis for the duration of the OS install. The ISO file will be deleted from the LUN after the new guest VM has been staged, and before the guest VM is converted to a SAN copy-capable template.

- j. Click **Next** when finished with the **Configure Hardware** tab.
5. Under **Select Destination**, choose **Place the virtual machine on a host** and choose the desired host group from the drop-down list where the target host is located. Click **Next**.
6. Under **Select Host**, choose the host with the new LUN mapped as the **G:\** drive (**TSSRV211** in this example) and click **Next**.

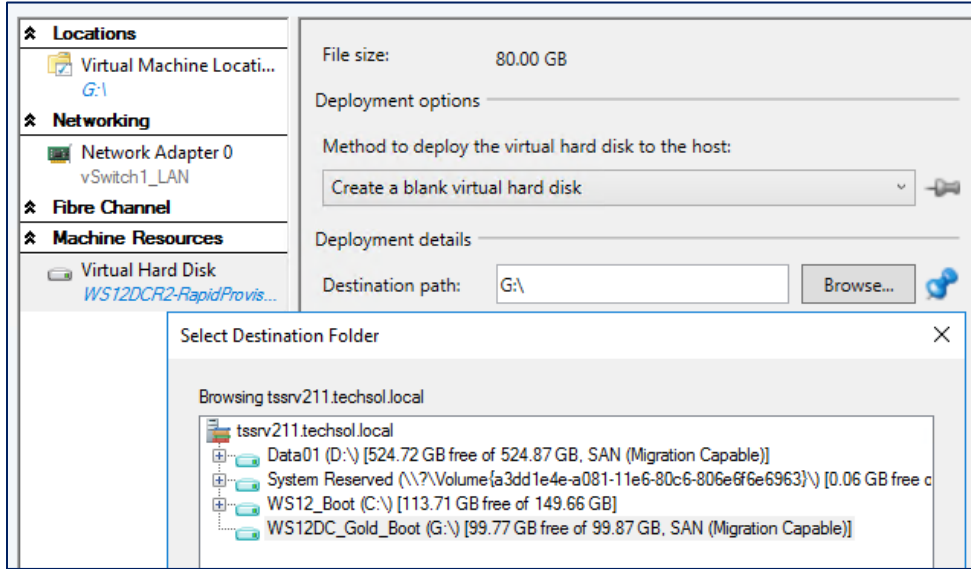


7. Under **Configure Settings**, set the following parameters:
  - a. Click **Browse** and change the virtual machine path to the root of the **G:\** drive. The VM must be installed at the root of this drive to support rapid provisioning.
  - b. Verify that the wizard indicates that the drive is **SAN Migration Capable**.



- c. Under **Machine Resources**, click **Virtual hard disk** and verify that **Create a blank virtual hard disk** is selected.

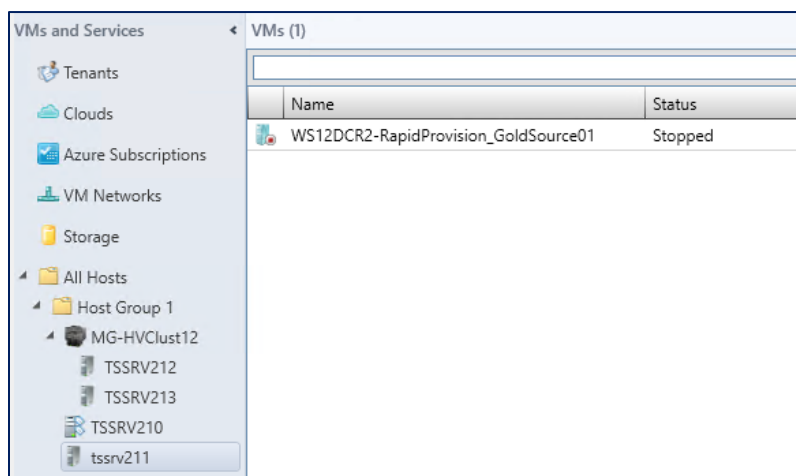
- d. Click **Browse** and set the path to the root of the **G:\** drive. Click **Next**.



8. Under **Add Properties**, configure the settings as desired, including selecting the operating system that will be installed on the guest VM, and click **Next**.
9. Under the **Summary** tab, review the settings and click **Create** to launch the **Create virtual Machine** job.
10. Monitor the progress of the **Create virtual machine** job. One of the job steps is to copy the ISO file from the library server to the **G:\** drive on the target host server. Fast File Copy indicates ODX is supported. This ISO file, used for staging only, will be deleted after the guest VM has been staged, and before it is converted to a template.

Create virtual machine				
Status:	23 %			
Command:	New-SCVirtualMachine			
Result name:	WS12DCR2-RapidProvision_GoldSource01			
Started:	11/8/2016 1:11:51 PM			
Duration:	00:00:05			
Owner:	TECHSOL\mglasser			
Step	Name	Status	Start Time	
1	Create virtual machine	23 %	11/8/2016 1:11:51 PM	
1.1	Create virtual machine	Completed	11/8/2016 1:11:53 PM	
1.2	Deploy file (using Fast File Copy): 0 o...	43 %	11/8/2016 1:11:54 PM	
1.3	Deploy file (using LAN)	Not started		
1.4	Change properties of virtual machine	Not started		

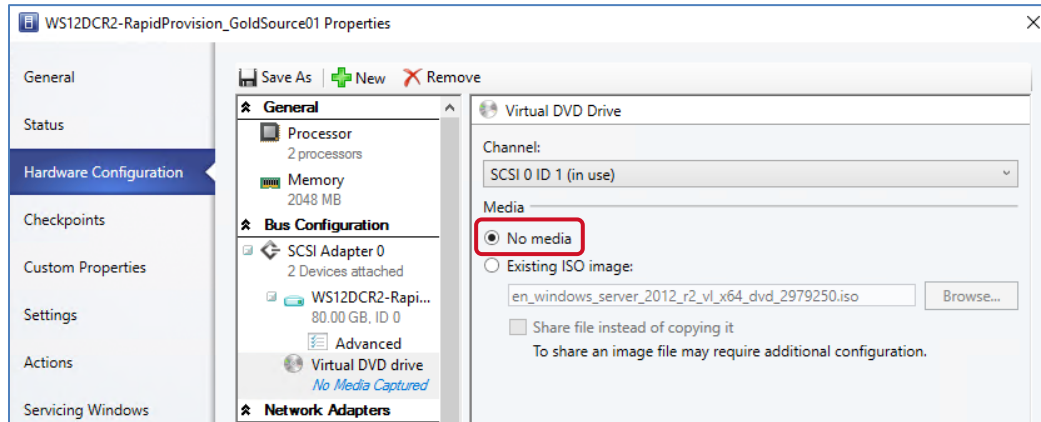
11. Once the **Create virtual machine** job completes, verify that the new guest VM is displayed under the target host in the **VMs and Services** workspace. In this example, the new guest is listed under the host server **TSSRV211**.



12. Power on the new guest and complete the following steps:
- Boot to the installation media (the ISO file) and install the OS.
  - Install and configure any desired roles, features, or applications.
  - Customize any settings.
  - Patch to desired levels.
  - Make any other desired customizations.
  - After the new guest has been fully staged, power it off.

**Note:** Do not run sysprep on this guest VM before powering it down. It will render the guest unusable as a source for the SAN copy-capable template. SCVMM will run sysprep on the guest automatically before it is imported to the library server as a template.

13. Remove the ISO image file that was used to stage the server OS, unless making the ISO part of the gold image is desired. If the ISO is not removed, it will become part of the gold image template.
  - a. Go to **VMs and Services > All Hosts**, right-click the new guest VM, and select **Properties**. In this example, the guest VM is located on the host **TSSRV211**.
  - b. Under **Hardware Configuration**, go to **Bus Configuration** and click **Virtual DVD drive**.
  - c. Select the option **No Media** and click **OK**.



- d. SCVMM deletes the ISO file from the LUN on the host server (from the **G:\** drive in this example) to recover the disk space.

## 9.4 Verify correct firmware boot order for generation-2 guests

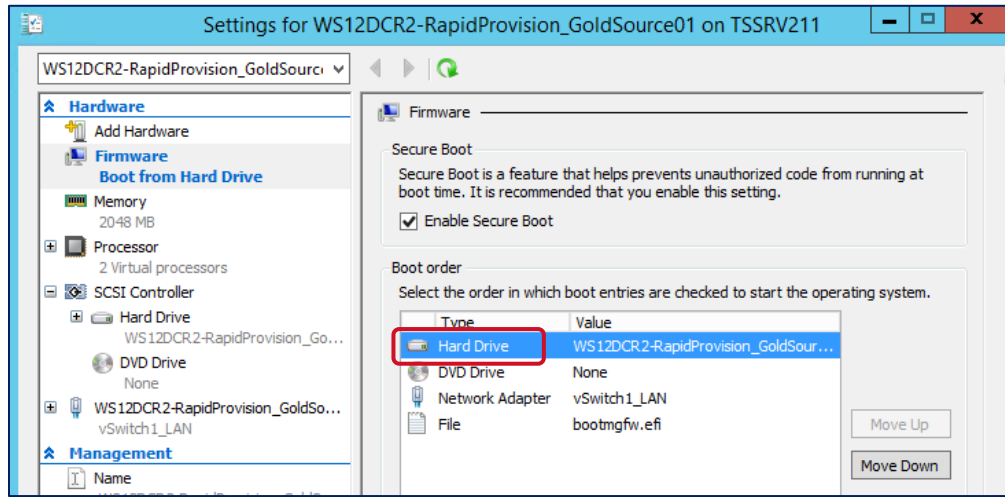
If the guest VM is configured as a generation-2 guest (as in this example), adjust the boot order for the VM so **Hard Drive** is listed as the first boot device. This must be done before cloning the VM or converting it to a template.

**Note:** Failure to adjust the boot order on a generation-2 guest VM before converting it to a SAN copy-capable template may render any guest VMs deployed from the template unbootable.

1. On the physical host server that was used to stage the guest VM (**TSSRV211** in this example), launch Hyper-V Manager.
2. Right-click the guest VM and choose **Settings**.



3. Under **Hardware > Firmware**, change the boot order so that **Hard Drive** is listed first. The boot order for the remaining boot entries is a matter of personal preference.



4. Click **OK** to save the changes, and close Hyper-V Manager.

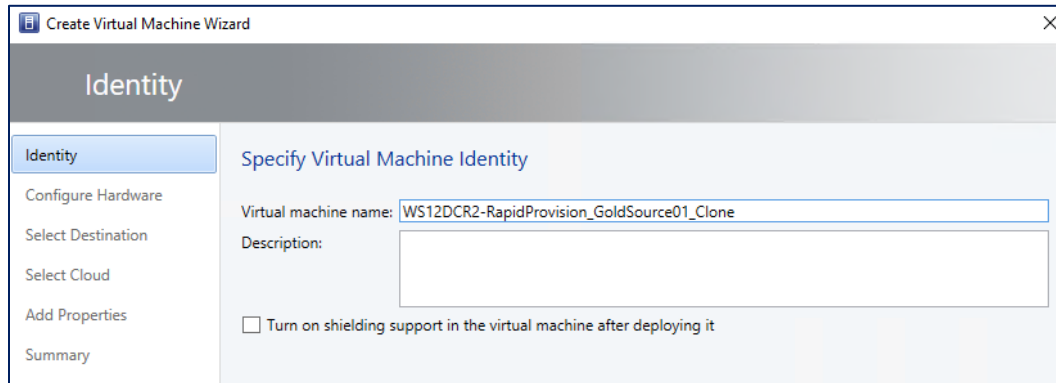
## 9.5 Create a clone of the guest VM

Creating a SAN copy-capable template from a guest VM destroys the VM when it is imported to the library server. If desired (recommended), create a clone of the VM before importing it. The clone can be used later to create new templates without having to stage a new VM from scratch.

To create a clone of the guest VM, complete the following steps:

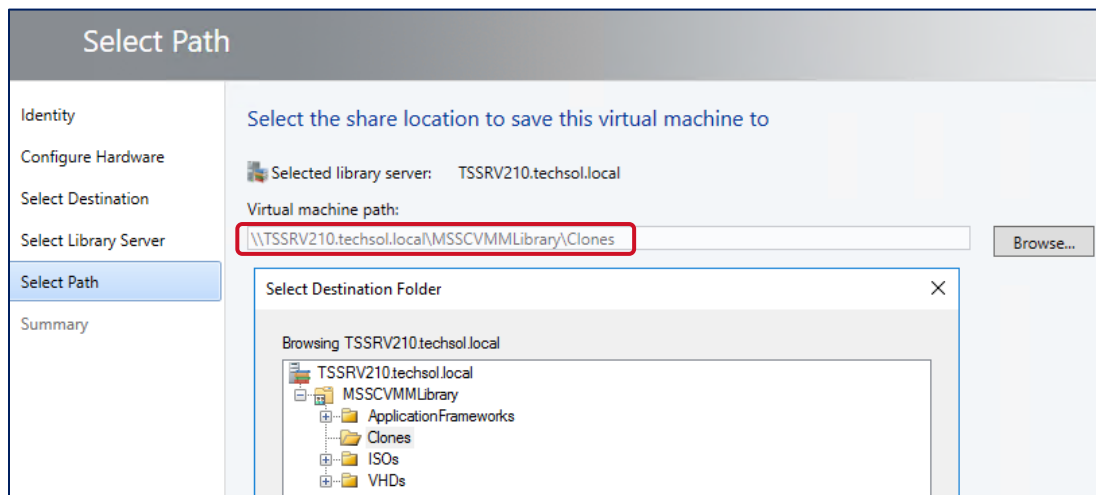
1. Power off the guest VM.
2. In SCVMM, right-click the guest VM and select **Create > Clone** to launch the **Create Virtual Machine Wizard**.

- Under the **Identity** tab, provide a descriptive name for this clone. In this example, **\_Clone** is added to the default name. Click **Next**.



The screenshot shows the 'Create Virtual Machine Wizard' window with the 'Identity' tab selected. The left sidebar lists the steps: Identity, Configure Hardware, Select Destination, Select Cloud, Add Properties, and Summary. The main area is titled 'Specify Virtual Machine Identity'. It contains a 'Virtual machine name' field with the text 'WS12DCR2-RapidProvision\_GoldSource01\_Clone', a 'Description' text box, and a checkbox labeled 'Turn on shielding support in the virtual machine after deploying it' which is currently unchecked.

- Under **Configure Hardware**, click **Next**.
- Under **Select Destination**, choose **Store the virtual machine in the library** and click **Next**.
- Under **Select Library Server**, select the desired library server (**TSSRV211** in this example), and click **Next**.
- Under **Select Path**, click **Browse** and select a location on the library server for the clone. If desired (optional) pause here to create a dedicated folder (named **Clones** in this example) under the library server share as a destination for cloned VMs. Click **Next**.



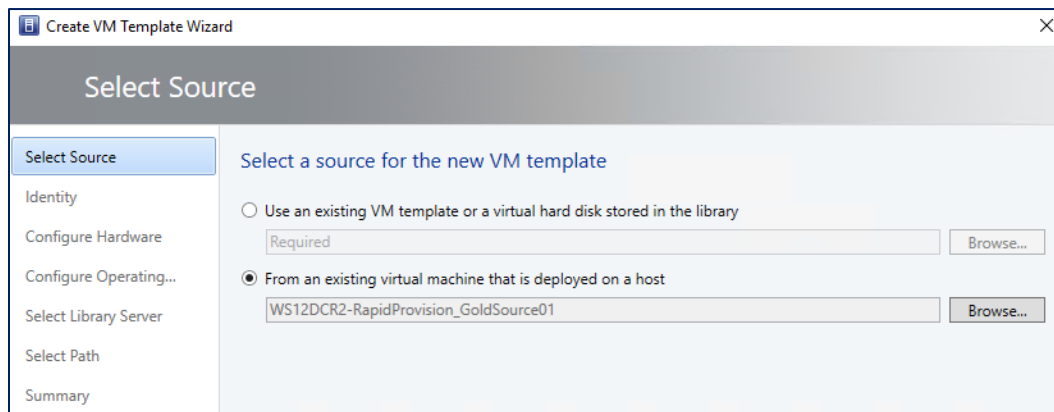
The screenshot shows the 'Select Path' tab of the 'Create Virtual Machine Wizard'. The left sidebar highlights 'Select Path'. The main area is titled 'Select the share location to save this virtual machine to'. It shows 'Selected library server: TSSRV210.techsol.local'. The 'Virtual machine path:' field contains '\\TSSRV210.techsol.local\\MSSCVMMLibrary\\Clones', which is highlighted with a red rectangle. A 'Browse...' button is to the right. Below this, a 'Select Destination Folder' dialog box is open, showing a file explorer view of 'Browsing TSSRV210.techsol.local'. The tree view shows 'TSSRV210.techsol.local' > 'MSSCVMMLibrary' > 'Clones' selected.

- Under **Summary**, review the settings and click **Create**. Monitor the **Create virtual machine** job until it completes.
- To view the clone, go to the **Stored Virtual Machines and Services** folder on the library server.

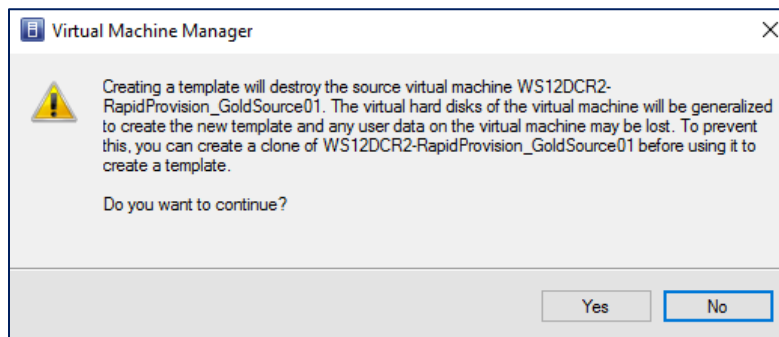
## 9.6 Create a SAN copy-capable template from a guest VM

Now that the guest VM has been staged, configured, and cloned, it is now ready to be imported to the library server as a SAN copy-capable template. Once imported, this template can be used to rapid provision new guest VMs. The steps are as follows:

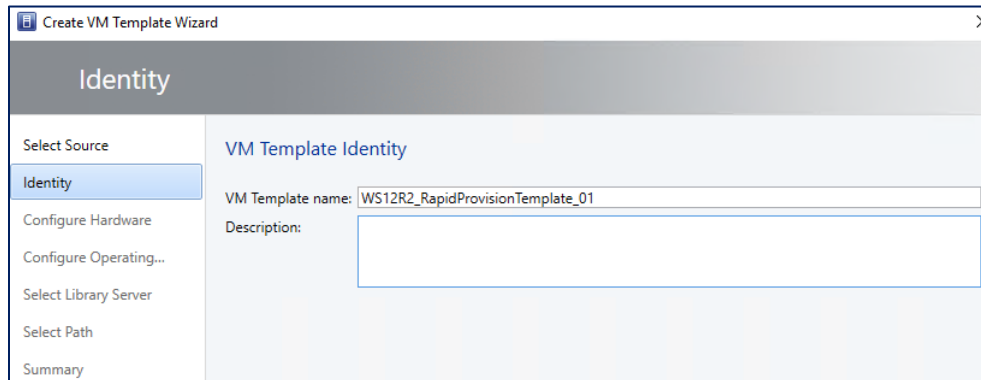
1. In SCVMM, go to **Library > Templates > VM Templates** and on the ribbon (under the **Home** tab), click **Create VM Template** to launch the **Create VM Template** wizard.
2. Under **Select Source**, select the option **From an existing virtual machine that is deployed on a host**.
3. Click **Browse** to display a list of available VMs. In this example, the VM named **WS12DCR2-RapidProvision\_GoldSource01** is selected. Click **Next**.



4. Review the warning message and click **Yes** to continue.



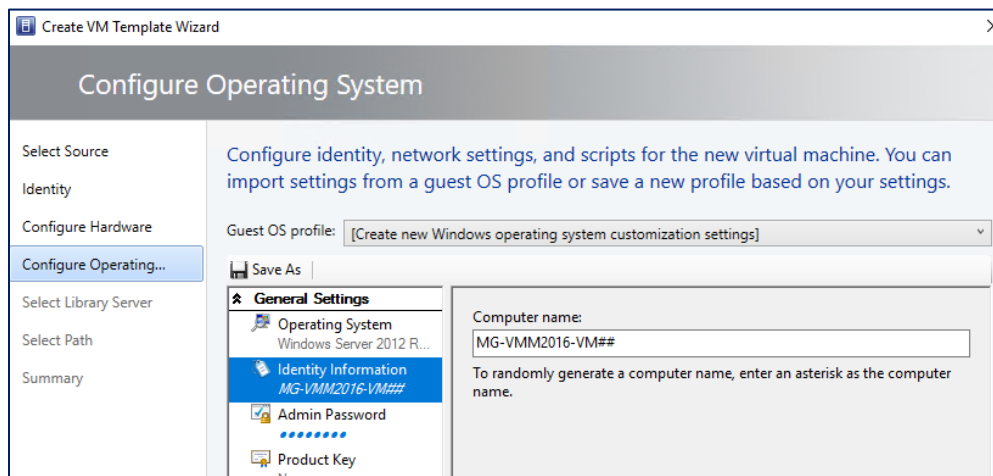
5. Under **Identity**, provide a name for the VM template. Click **Next**.



The screenshot shows the 'Create VM Template Wizard' window with the 'Identity' tab selected. The left sidebar contains a list of steps: 'Select Source', 'Identity' (highlighted), 'Configure Hardware', 'Configure Operating...', 'Select Library Server', 'Select Path', and 'Summary'. The main area is titled 'VM Template Identity' and contains two fields: 'VM Template name:' with the value 'WS12R2\_RapidProvisionTemplate\_01' and 'Description:' with an empty text box.

6. Under **Configure Hardware**, review and adjust any setting, or choose a hardware profile from the drop-down list. Click **Next**.
7. Under **Configure Operating System**, review and adjust any settings, or choose a guest OS profile from the drop-down list. Click **Next**.

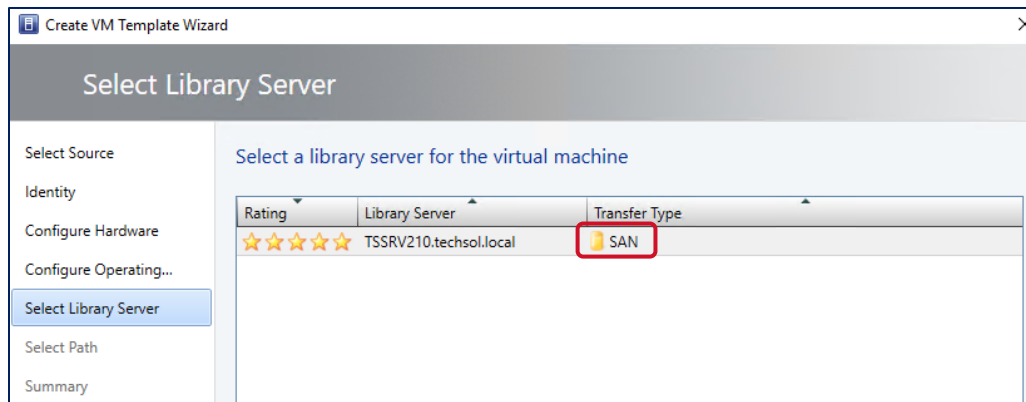
**Tip:** In this example, the **Computer Name** is set to **MG-VMM2016-VM##** where **MG-VMM2016-VM** is the base name for new VMs and **##** represents a placeholder for automatic incremental VM numbering. The first VM deployed from the template is named **MG-VMM2016-VM01**, the second is named **MG-VMM2016-VM02**, and so forth.



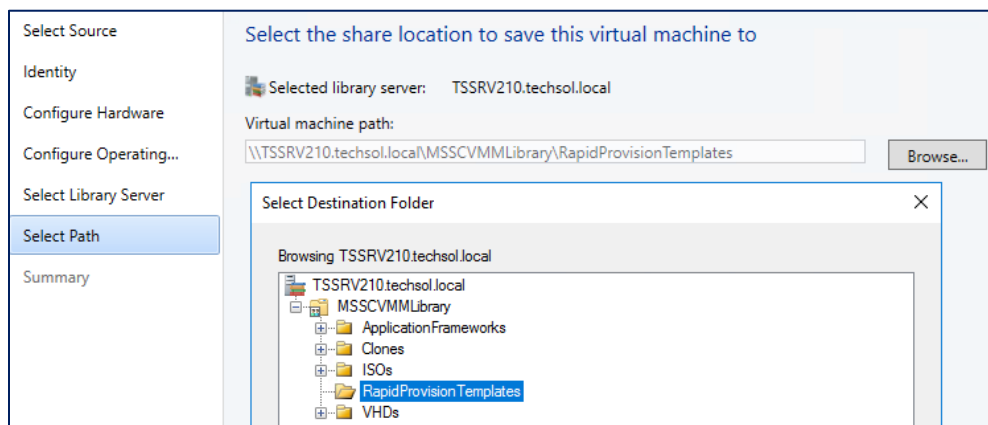
The screenshot shows the 'Create VM Template Wizard' window with the 'Configure Operating System' tab selected. The left sidebar shows the same list of steps, with 'Configure Operating...' highlighted. The main area has a title bar 'Configure Operating System' and a subtitle 'Configure identity, network settings, and scripts for the new virtual machine. You can import settings from a guest OS profile or save a new profile based on your settings.' Below this is a 'Guest OS profile:' dropdown menu showing '[Create new Windows operating system customization settings]'. A 'Save As' button is visible. A 'General Settings' section is expanded, showing a list of settings: 'Operating System' (Windows Server 2012 R...), 'Identity Information' (MG-VMM2016-VM##, highlighted), 'Admin Password' (with a strength indicator), and 'Product Key' (None). To the right of this list, the 'Computer name:' field is set to 'MG-VMM2016-VM##' and a note states: 'To randomly generate a computer name, enter an asterisk as the computer name.'

8. Under **Select Library Server**, select the desired library server. In this example, **TSSRV210** is selected. Click **Next**.

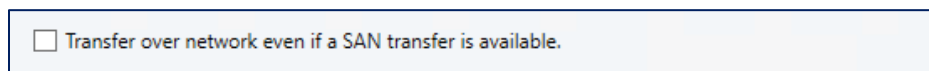
**Note:** The **Transfer Type** column must indicate **SAN** (not network) in order for this template to support rapid provisioning.



- Under **Select Path**, click **Browse** and choose a destination on the library server for the rapid provisioning guest VM template. If desired, pause here to create a specific folder on the library server for rapid provisioning templates as shown in the following example. Click **Next**.



- Verify that the **Transfer over network even if a SAN transfer is available** option is deselected (the default). Click **Next**.



- Review the **Summary** screen and click **Create**. This launches the **Create template** job in SCVMM.

12. Monitor the progress in the **Create template** job until it completes. One of the steps in the job is to sysprep the VM before it is imported to the library server as a template.

Create template		
Step	Name	Status
1	Create template	25 %
1.1	Sysprep virtual machine	50 %
1.1.1	Start virtual machine for sysprep	Completed
1.1.2	Stop virtual machine	Not started
1.2	Deploy virtual machine	Not started

13. Once the job has finished, go to **Library > Templates > VM Templates** and verify that the new rapid-provision VM template is **SAN Copy Capable**. If this column is not listed, right-click the column header row and select this option from the drop-down list.

Templates (1)					
Name	Type	Owner	SAN Copy Capable	Status	
WS12R2_RapidProvisionTemplat	VM Template	TECHSOL\m...	Yes	OK	

14. Right-click the template and under **Properties > Access**, grant access to any self-service users or roles if desired.
15. Under **Hardware Configuration > Bus Configuration**, click the boot virtual hard disk. From the drop-down list, select the desired storage classification for the SC Series array managed by SCVMM (**SC17** in this example). Click **OK** to save the changes and exit.

WS12R2\_RapidProvisionTemplate\_01 Properties

General

Hardware Configuration

OS Configuration

Application Configuration

SQL Server Configuration

Custom Properties

Settings

Dependencies

Validation Errors

Access

Save As

New

Remove

Compatibility

Cloud Capability Prof...

Hyper-V

General

Processor

2 processors

Memory

2048 MB

Bus Configuration

SCSI Adapter 0

2 Devices attached

WS12DCR2-Rapid...

80.00 GB, ID 0

Virtual DVD drive

No Media Captured

Network Adapters

Network Adapter 1

Connected to vSwitch1...

Fibre Channel Adapters

Advanced

WS12DCR2-RapidProvision\_GoldSource01\_Boot

Channel:

SCSI 0 ID 0 (in use)

Contains the operating system for the virtual machine

Share the disk across the service tier

Create a differencing disk using the specified disk as the parent.

\\TSSRV210.techsol.local\MSSCVMMLibrary\RapidProvisionTem

Browse...

Virtual hard disk type: Dynamic

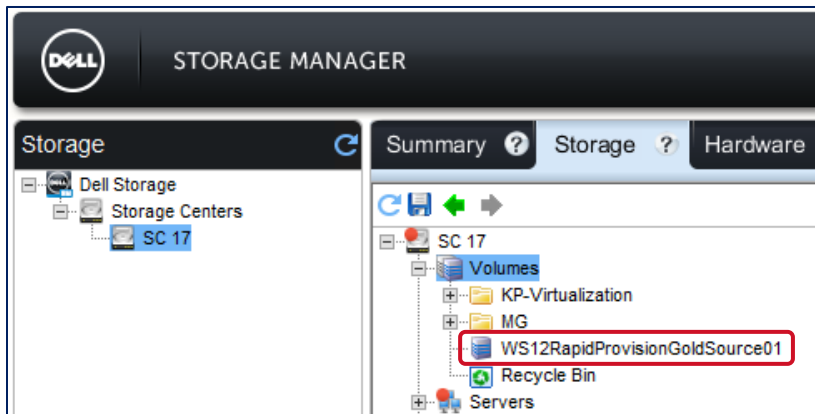
Maximum size: 80.00 GB

Currently expanded to: 11.55 GB

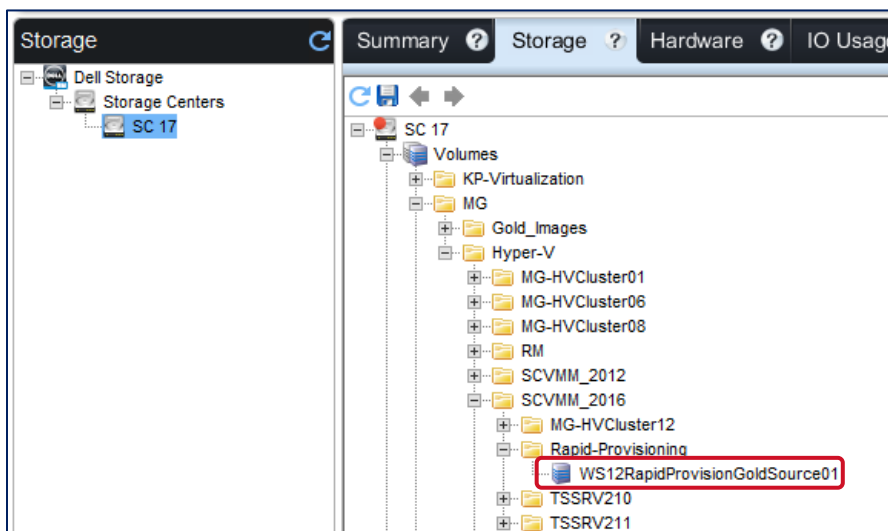
Classification:

SC17

16. The SAN volume that hosts the template is placed at the root of the **Volumes** in DSM when it is imported to the library server.



17. As a recommendation, move this volume to a subfolder rather than leaving it at the root of the Volumes folder. Moving the volume will not impact SCVMM functionality.



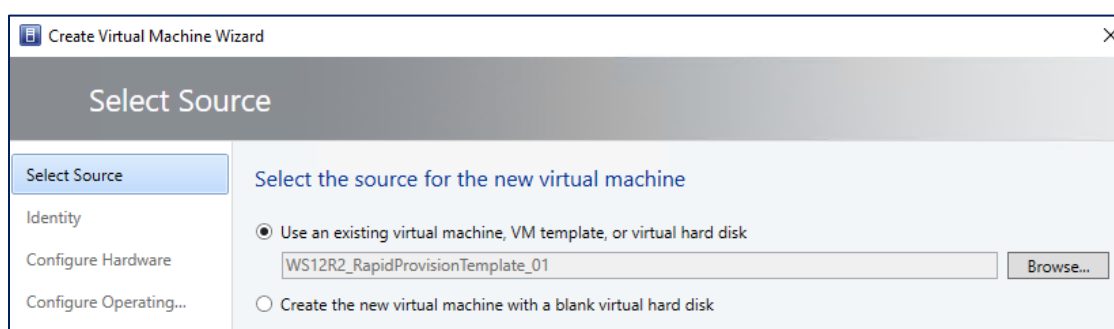
18. The template can now be used for rapid provisioning of new guest VMs as shown in section 10.

## 10 Rapid provisioning with SAN copy-capable templates

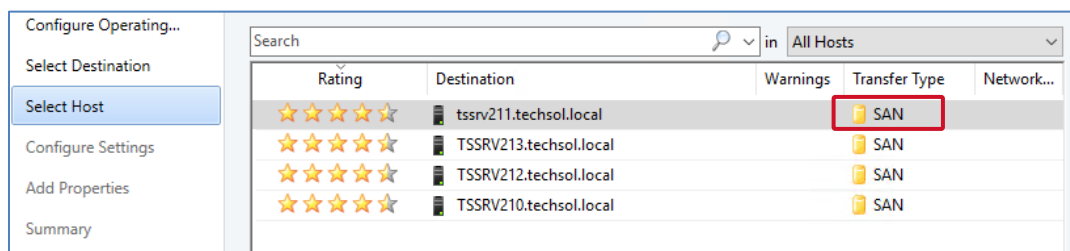
The SAN copy-capable template created previously can now serve as a gold image for rapid provisioning of new guest VMs, leveraging SC Series array snapshots. Follow the steps in this section to deploy guest VMs from this template and gain a more in-depth understanding of how this integration works.

### 10.1 Create new VM with rapid provisioning

1. In the SCVMM console, go to **VMs and Services** and on the ribbon (under the **Home** tab), click **Create Virtual Machine**.
2. Under **Select Source**, select **Use an existing virtual machine**. Click the **Browse** button, and select the desired rapid provisioning template. Click **Next**.



3. Under the **Identity** tab, provide a name, or allow the wizard to assign a name. Click **Next**.
4. Under **Configure Hardware**, modify the options if desired and click **Next**.
5. Under **Configure Operating System**, modify the options if desired and click **Next**.
6. Under **Select Destination**, choose to deploy the VM to a private cloud or a host and click **Next**.
7. Under **Select Host**, choose a target server for the VM deployment. In this example, the VM is deployed to a Hyper-V host named **TSSRV211**. Make sure the **Transfer Type** column for this server indicates support for SAN.



8. Under **Configure Settings**, review the VM settings and click **Next**.
9. Under **Add Properties**, click **Next**.
10. On the **Summary** screen, click **Create**.
11. Monitor the status of the **Create Virtual Machine** job in SCVMM until it completes successfully.



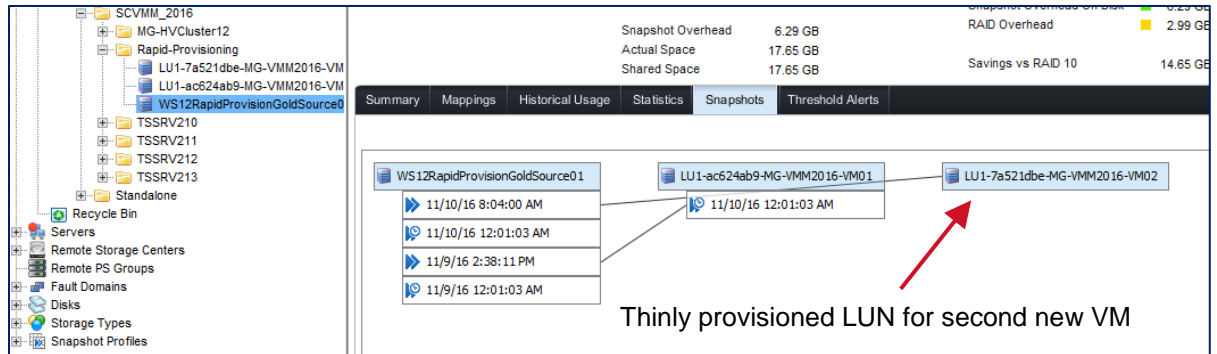
One of the incremental steps associated with rapid provisioning is the creation of a new storage LUN from a snapshot of the gold source on the SC Series array.

Status: <div><div></div></div> 4 %	Step	Name	Status	Start Time
Command: New-SCVirtualMachine	1	Create virtual machine	<div><div></div></div> 4 %	11/9/2016 2:37:14 PM
Result name: MG-VMM2016-VM01	1.1	Rapid deploy using SAN copy	<div><div></div></div> 33 %	11/9/2016 2:37:17 PM
Started: 11/9/2016 2:37:14 PM	1.1.1	Parallel execution step	Completed	11/9/2016 2:37:17 PM
Duration: 00:00:07	1.1.1.1	Creates new storage logical unit	Completed	11/9/2016 2:37:17 PM
Owner: TECHSOL\mgclaser	1.1.2	Registers Storage Logical Unit to h...	<div><div></div></div> 0 %	11/9/2016 2:37:37 PM
	1.1.3	Parallel execution step	Not started	

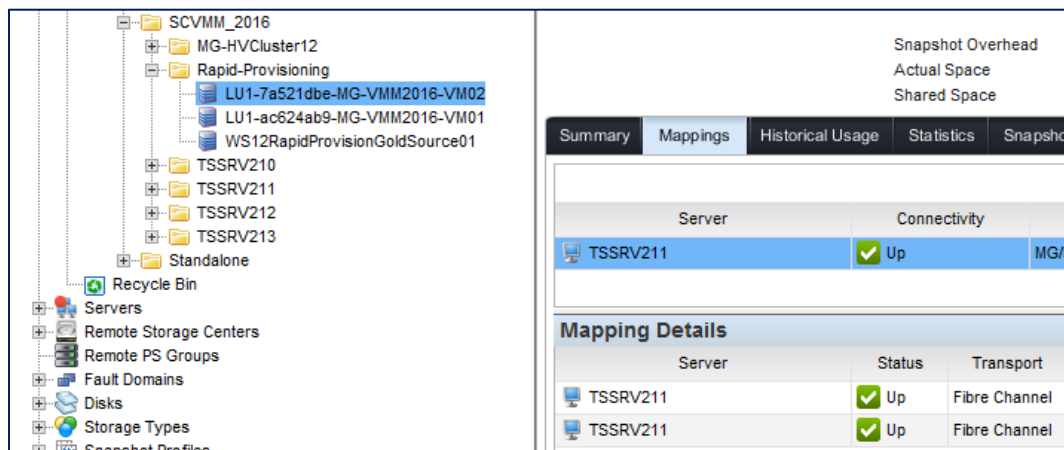
- To view the new LUN (optional), use DSM. Under **Storage > Volume** tree, click the gold image source volume and click the **Snapshots** tab. Change **Select View** to **Tree View** to see the relationship between the gold image source LUN, snapshots, and new thinly provisioned LUNs.

The screenshot displays the Dell EMC Storage Management Console interface. On the left, a tree view shows the hierarchy: SCVMM\_2016 > MG-HVCluster12 > Rapid-Provisioning > LU1-ac624ab9-MG-VMM2016-VM01 > WS12RapidProvisionGoldSource01. A red arrow points from the text 'Gold image source LUN' to 'WS12RapidProvisionGoldSource01'. Another red arrow points from the text 'Snapshot' to a snapshot entry in the 'Snapshots' tab, which shows two snapshots: '11/9/16 2:38:11 PM' and '11/9/16 12:01:03 AM'. A third red arrow points from the text 'Thinly provisioned LUN from snapshot for first new VM' to 'LU1-ac624ab9-MG-VMM2016-VM01'. The right pane shows the 'Snapshots' tab for 'WS12RapidProvisionGoldSource01', displaying statistics: Snapshot Overhead (6.29 GB), Actual Space (17.65 GB), and Shared Space (17.65 GB).

Each additional VM that is rapidly provisioned from the SAN copy-capable template will result in the creation of another thinly provisioned LUN from a snapshot of the source volume that serves as the gold image. These thinly provisioned LUNs consume no space initially. VMs access existing data from the gold source volume. New data is written to the thinly provisioned LUNs.



- When a new LUN is mapped to a target host or cluster, it is presented as a mount point so no drive letters are consumed. Click the **Mappings** tab to view the mappings for a new LUN. Fibre Channel mappings are used in this example.



## 10.2 SAN space saved with rapid provisioning

SAN space savings is significant when using rapid provisioning. In the example shown in Table 3, when five Windows Server 2102 R2 VMs are deployed using a network copy template as compared to a SAN copy-capable template, 67.5 GB of space is saved on the SAN.

Table 3 SAN space usage comparison

	Network copy template	SAN copy-capable template
Space consumed on the SAN for the template (virtual hard disk and configuration files)	15 GB	15 GB
New guest VM 1	15 GB	1.5 GB
New guest VM 2	15 GB	1.5 GB
New guest VM 3	15 GB	1.5 GB
New guest VM 4	15 GB	1.5 GB
New guest VM 5	15 GB	1.5 GB
Total SAN space consumed by new guest VMs	75 GB (5 x 15 GB)	7.5 GB (5 x 1.5 GB)
Total SAN space saved	0 GB	67.5 GB

With a network copy template, a full copy of the source data is transferred to the target host or cluster for each new VM deployed so no space savings are realized on the SAN.

With a SAN copy-capable template, a thinly provisioned copy of the source LUN is created and mapped to the target host or cluster as a mount point, which initially consumes no SAN space. Because the VM looks to the gold source for existing data, only new or changed data is written to the new LUN. In this example, each new VM creates about 1.5 GB of new data upon first boot because the gold source represents a generalized VM image (using sysprep). Upon first boot, about 1.5 GB of new data is created as the VM sets up a user profile.

While the SC Series array will not impose any restriction on the number of guest VMs that can be deployed from a SAN copy-capable template, factors such as I/O demand may result in eventually reaching a functional limit as more and more guest VMs are deployed from the same template. Monitoring is required to ensure that performance stays at an acceptable level as more VMs are deployed. Create and use additional SAN copy-capable templates as a way to ensure balanced controllers and acceptable performance if a large number of VMs will be deployed with rapid provisioning.

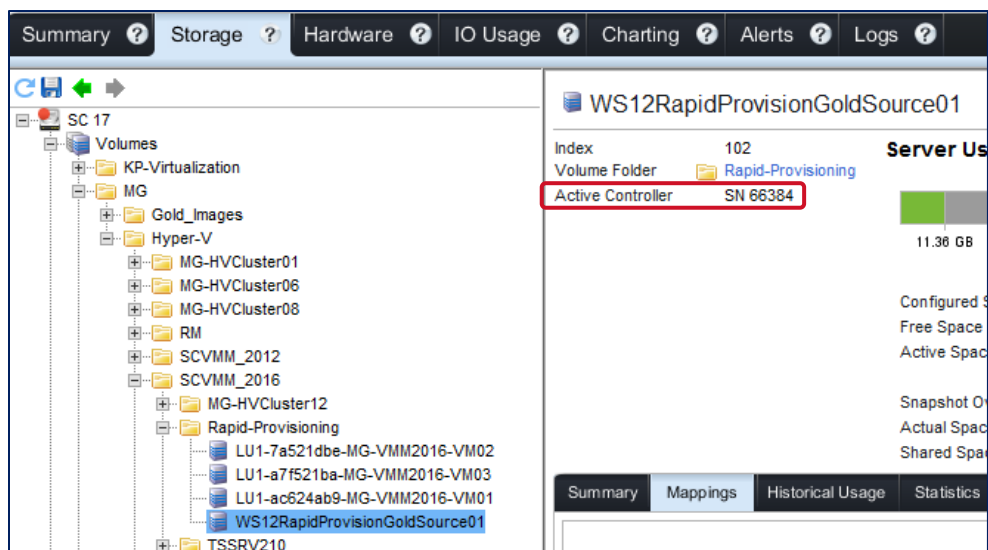
## 10.3 Maintain balanced SC Series array controllers with rapid provisioning

An SC Series array is typically comprised of two controllers. By default, each new volume created on the SC Series array is assigned to one controller or the other in a round robin fashion. This helps keep the I/O load on each controller balanced.

However, when using a SAN copy-capable template to deploy VMs, new LUNs will always be owned by the same controller as the gold image source LUN specified in the template. This can lead to unbalanced controllers if a large number of VMs are provisioned from the same SAN copy-capable template.

To help keep the SC Series array controllers balanced, an administrator can create an additional SAN copy-capable template where the source LUN is owned by the other controller.

To verify which SC Series controller owns a volume, use DSM to view the properties for the volume. In this example, the gold image source volume is owned by controller **66384** which is the bottom controller in the pair.



In SCVMM, edit the properties for the SAN copy-capable template, and under **General**, provide a description to indicate which SC Series controller owns the gold image volume.

WS12R2\_RapidProvisionTemplate\_01 Properties

General

Hardware Configuration

OS Configuration

Application Configuration

Name: WS12R2\_RapidProvisionTemplate\_01

Description: Gold Image LUN owned by SC17, controller SN 66384 (bottom)

Cost center:

Tag: (none)

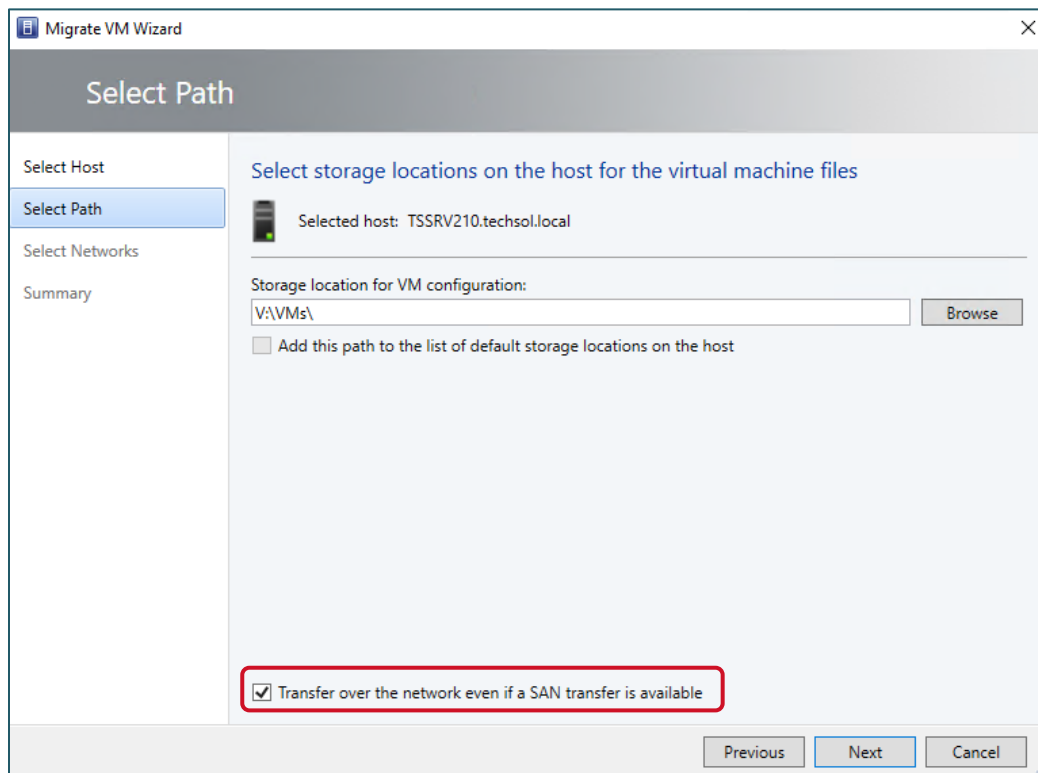
When deploying a large number of VMs, alternate between different SAN copy-capable templates to help keep the SC Series controllers balanced.

## 11 Migrate guest VMs with SAN transfer

Another feature that SMI-S integration provides with SCVMM and SC Series storage is SAN transfer. With SAN transfer, VMs are quickly migrated from one standalone Hyper-V host to another by unmapping and remapping SAN volumes on the hosts instead of copying data over the network or using Windows Offloaded Data Transfer (ODX). This is beneficial when a guest VM has a large amount of data that would take a significant amount of time to copy.

However, there are scenarios in which using SAN transfer may not be desirable, possible, or preventable, such as the following:

- When the Migrate VM Wizard detects that SAN transfer is supported, SCVMM will use SAN transfer as the default means for migrating a guest VM.
- If preserving the SAN volume mappings on the source server is desired, perform a network copy. In the Migrate VM Wizard, enable the option, **Transfer over the network even if a SAN transfer is available**. For a network copy, ODX is leveraged if enabled and supported.
- If the source volume contains more than one guest VM, SAN transfer is not supported.
- Hyper-V clusters do not support SAN transfer between nodes of the same cluster. Traditional VM live migration is leveraged instead.
- When the Migrate VM Wizard detects that SAN transfer is supported, SAN transfer will always be used when a guest VM is migrated from a standalone Hyper-V host to a Hyper-V cluster. If using SAN transfer is not desired in this situation, migrate the VM using an alternate method outside of SCVMM.



## 12 Modify volume mappings

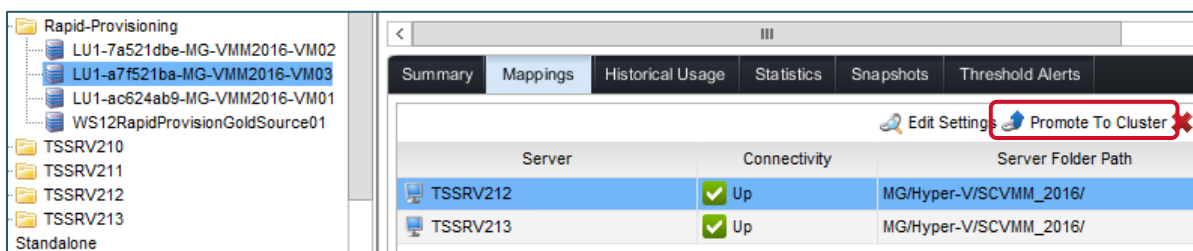
When SCVMM leverages SMI-S to present a SAN volume to a Hyper-V cluster (either as a new volume, or as part of a guest VM migration using SAN transfer), the volume is mapped to each node of the cluster individually on the SC Series array, not to a cluster server object on the SC Series array, if a cluster object exists.

While modifying the volume mappings is not required, there are some advantages from a best practices/management standpoint to have a cluster volume mapped to a cluster server object on the SC Series array instead of to individual cluster nodes. For example, if an administrator adds a new node to an existing cluster server object using DSM, all of the volumes mapped to the cluster server object are automatically mapped to the new node using consistent LUN numbers. This avoids having to manually and individually map existing cluster volumes to the new node, which can be time consuming and error prone.

**Note:** Modifying volume mappings may interrupt I/O. If necessary, perform changes during a maintenance window.

In this example, a new LUN was mapped individually to two Hyper-V cluster nodes, TSSRV212 and TSSRV213, when SCVMM was used to rapidly provision a new VM using a SAN copy-capable template.

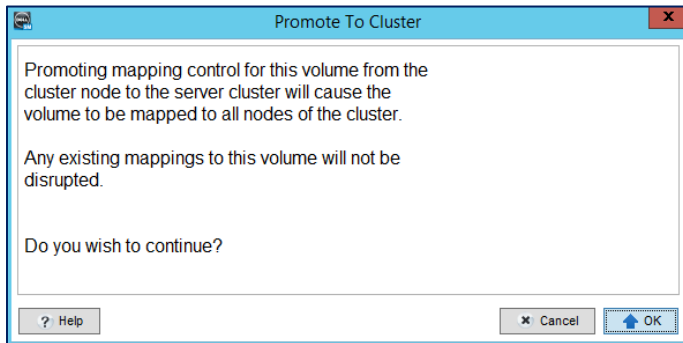
1. To convert the mappings from individual nodes to an SC Series cluster server object, use DSM. Under the **Mappings** tab for the desired volume, click **Promote to Cluster**.



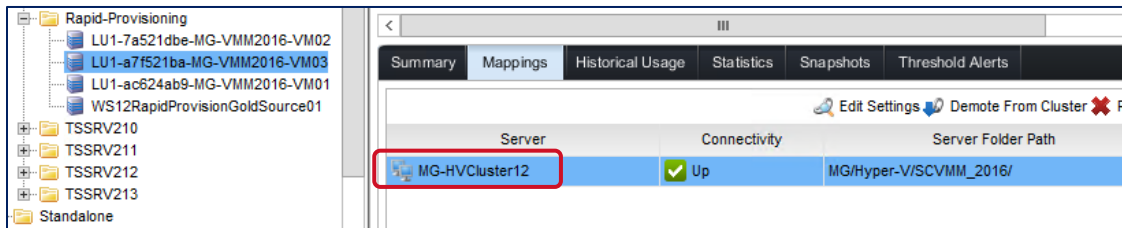
The screenshot shows the Dell EMC SC Series Storage Management Console. On the left, a tree view shows the hierarchy: Rapid-Provisioning > LU1-7a521dbe-MG-VMM2016-VM02 > LU1-a7f521ba-MG-VMM2016-VM03. The main pane shows the 'Mappings' tab for this volume. It displays a table with columns: Server, Connectivity, and Server Folder Path. Two servers are listed: TSSRV212 and TSSRV213, both with 'Up' connectivity. The 'Promote To Cluster' button is highlighted with a red box.

Server	Connectivity	Server Folder Path
TSSRV212	Up	MG/Hyper-V/SCVMM_2016/
TSSRV213	Up	MG/Hyper-V/SCVMM_2016/

2. Review the message and click **OK**.



3. After the wizard completes, the volume is now mapped to the SC Series cluster server object that contains TSSRV212 and TSSRV213 as member nodes.





## A Create OpenPegasus and local SMI-S users with PowerShell

For environments with EM Data Collector, it is necessary to run a PowerShell script (accessible from the EM program group) that automates the creation of an OpenPegasus SMI-S user and a local Windows Server user account.

This is not necessary with DSM 2016 R1 or newer, which uses version 1.6 of the SMI-S provider (based on JWBEM). It is only necessary for EM versions that use 1.5 of the SMI-S provider (based on OpenPegasus).

### A.1 PowerShell script overview

The **Launch SMIS User Configuration Script via PowerShell** script does two things:

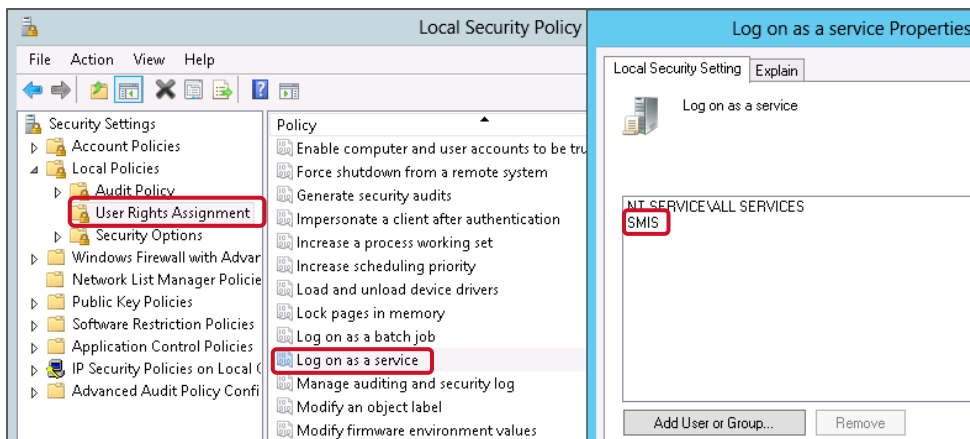
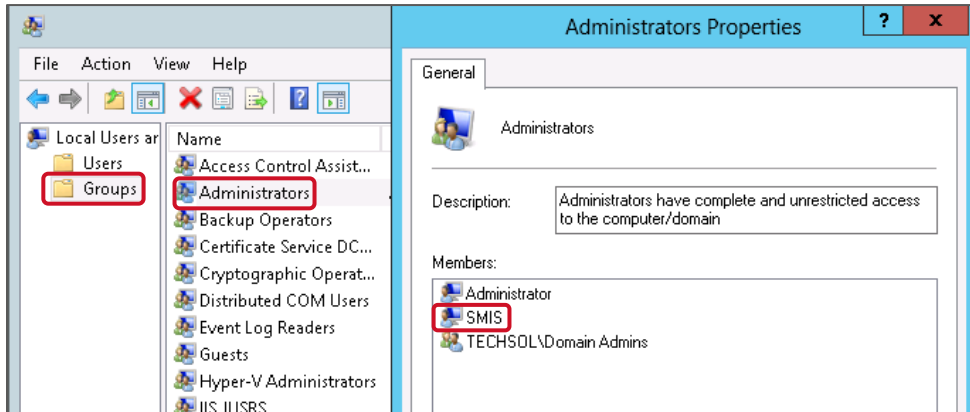
- Creates the OpenPegasus SMIS user
- Automates the process of creating a matching local Windows SMI-S user account on the Data Collector server, adding it to the local administrators group, and assigning it the **Log on as a service** right.

**Note:** If preferred, the local Windows SMI-S user account can be created manually on the Data Collector server. Perform this before running the PowerShell script.

## A.2 Create the local Windows SMI-S user account manually

If manually creating the local Windows SMI-S user account, verify that the user has local administrator rights and has the **Log on as a service** right assigned as shown in the following figures.

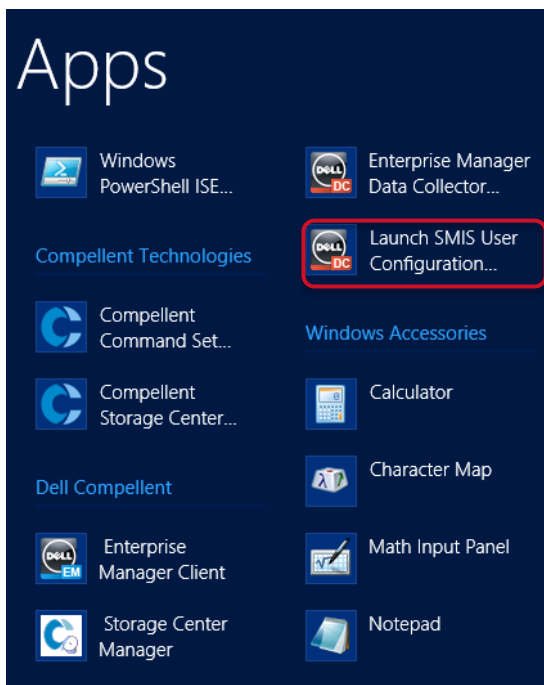
If creating the local Windows SMI-S user account by using the PowerShell script, see section A.3.



## A.3 Run the PowerShell script

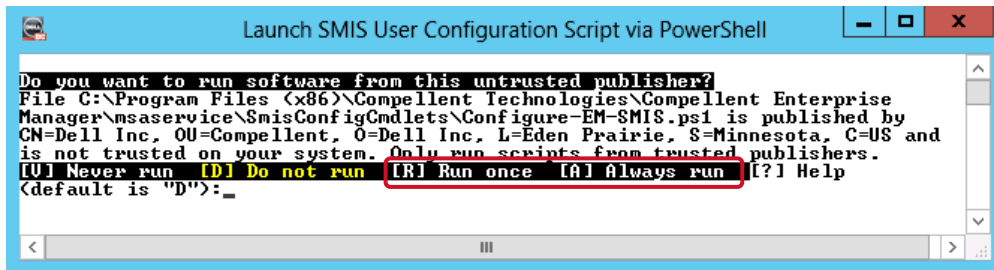
1. Log on to the server that is hosting the EM Data Collector as the local administrator user. Logging on as the local administrator user will help ensure that the PowerShell script completes successfully.
2. On the Data Collector server, go to **Start > All programs > Dell Compellent** and select **Launch SMIS User Configuration Script via PowerShell**.

**Note:** If the PowerShell script fails to launch, set the PowerShell **Local Machine Execution Policy** to **Unrestricted** temporarily.

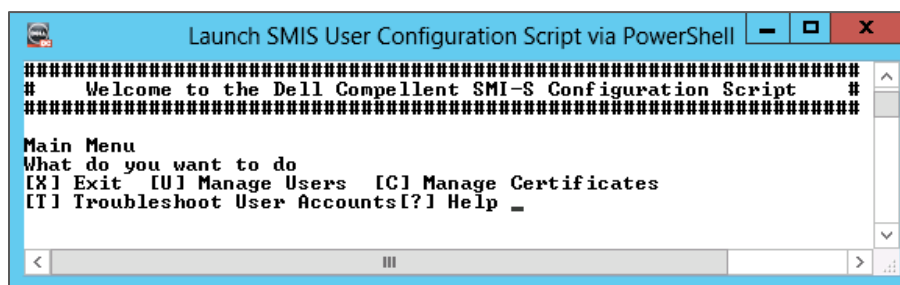


- Depending on the Local Machine Execution Policy for PowerShell on the Data Collector server, a security prompt may appear as shown in the following. If so, type **R** or **A** and press **Enter** to continue.

**Note:** If .Net v3.5 is not installed on the server, a .Net v3.5 warning message will appear. If this occurs, exit the script, install .Net 3.5, and restart the PowerShell script.

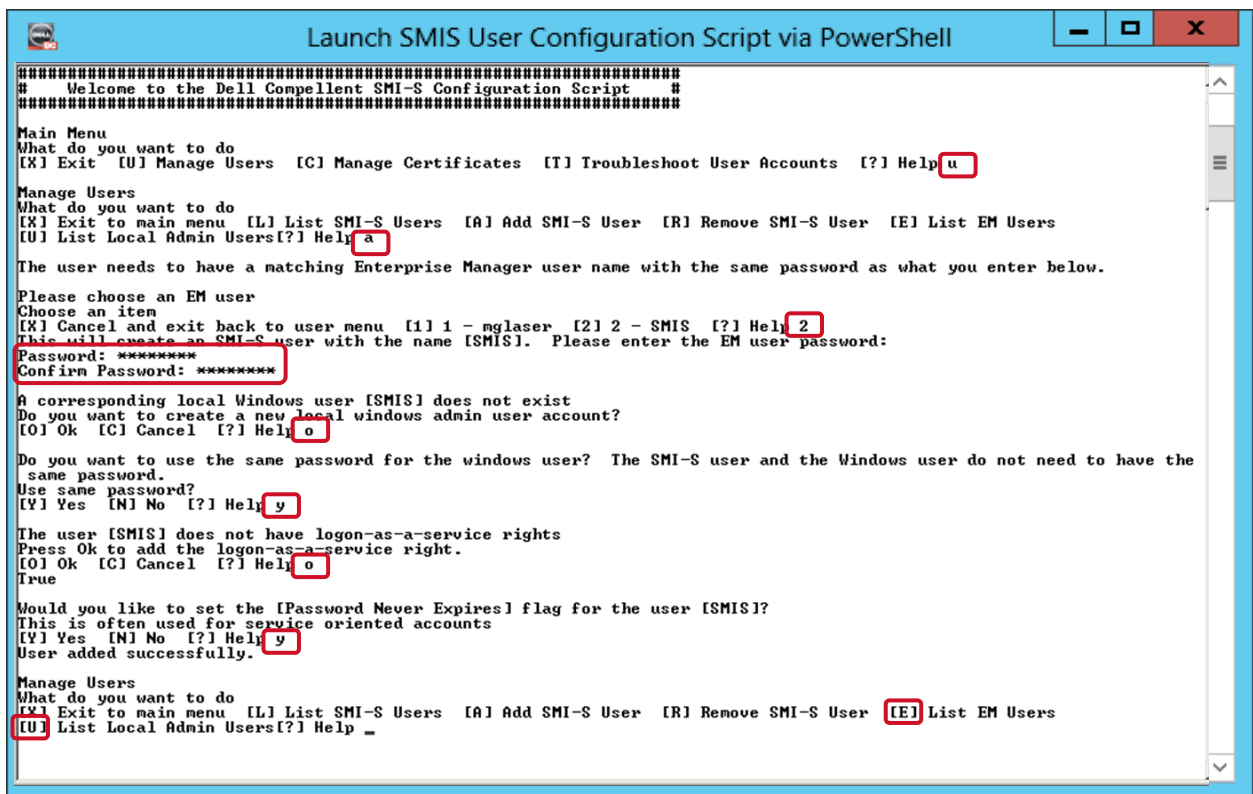


- The PowerShell script main menu is displayed.



5. Referring the following figure, at the PowerShell script main menu, type **U** to manage users and press **Enter**.
6. Under Manage Users, type **A** and press **Enter** to add an SMI-S User.
7. Select the number of the desired SMI-S Enterprise Manager (EM) users, which in this example is **2** (for the user **smis**) and press **Enter**.
8. Enter the SMI-S user password and press **Enter**.
9. Enter the password a second time to confirm it and press **Enter**.
10. If a corresponding local Windows SMI-S user does not yet exist, the script will prompt to create this user. Type **O** and press **Enter** to allow the script create this user.
11. Type **Y** to use the same password, or **N** to enter a different password. Using the same password is possible only if it meets the minimum complexity requirements for the Windows environment.
12. To grant the local Windows SMI-S user the **Logon as a service** right, type **O** and press **Enter**.
13. To set the password to never expire (recommended), type **Y** and press **Enter**.
14. To verify the creation of these user accounts, use the **List** menu options in the script (if desired).
15. When finished, type **X** and press **Enter** to return to the PowerShell script main menu.

If the Data Collector is configured to use **HTTPS** for communication with SCVMM, an SSL certificate needs to be associated with the SMI-S user. To do this, perform the following steps. If **HTTPS** will not be used, close the script.



16. Referring to the following figure, to add an SSL certificate and associate it with the SMI-S user, from the PowerShell Script main menu, type **c** and press **Enter** to manage certificates.
17. From the Manage Certificates menu, type **a** and press **Enter** to add an SSL certificate to the SMI-S trust store.
18. When prompted to associate a user, select the desired SMI-S user (the user **smis** in this example). Type the number for that user and press **Enter** to select it.
19. The PowerShell script returns the result **Certificate Added Successfully** and returns to the Manage Certificates menu.
20. Type **l** and press **Enter** to verify the presence of the certificate and view its details.
21. Type **x** and press **Enter** to return to the main menu.
22. Type **x** and press **Enter** twice to close the PowerShell command window.

```

Launch SMIS User Configuration Script via PowerShell
#####
# Welcome to the Dell Compellent SMI-S Configuration Script #
#####

Main Menu
What do you want to do
[X] Exit [U] Manage Users [C] Manage Certificates
[T] Troubleshoot User Accounts [?] Help c

Manage Certificates
What do you want to do
[X] Exit to main menu [L] List certificates
[A] Add default server SSL certificate to SMI-S trust store
[R] Remove a certificate [?] Help a

A user association is required because the default certificate is a self-signed
certificate
Pick a user to associate the default certificate with:
[X] Cancel and exit back to menu [1] 1 - SMIS [?] Help 1
Certificate added successfully.

Manage Certificates
What do you want to do
[X] Exit to main menu [L] List certificates
[A] Add default server SSL certificate to SMI-S trust store
[R] Remove a certificate [?] Help l

Certificates:
Issuer          : /C=US/ST=Minnesota/L=Eden
                  Prairie/O=DELL/OU=Compellent/CN=MG-DataC03
Subject         : /C=US/ST=Minnesota/L=Eden
                  Prairie/O=DELL/OU=Compellent/CN=MG-DataC03
SerialNumber    : 4294967295
RegisteredUserName : SMIS
CertificateType  : Self-signed identity
ValidNotBefore  : Jan 12, 2013 18:31:42 <+0000>
ValidNotAfter   : Jan 10, 2023 18:31:42 <+0000>
IssuerItems     :
SubjectItem     :

Manage Certificates
What do you want to do
[X] Exit to main menu [L] List certificates
[A] Add default server SSL certificate to SMI-S trust store
[R] Remove a certificate [?] Help x
  
```

## B Troubleshoot SMI-S and SC array discovery issues

On occasion, attempting to discover storage using SMI-S may fail. If any error messages are encountered when attempting to discover storage, follow the steps in this section to help resolve the problem. If assistance is needed, contact Dell Support.

If errors are encountered, review the following troubleshooting steps:

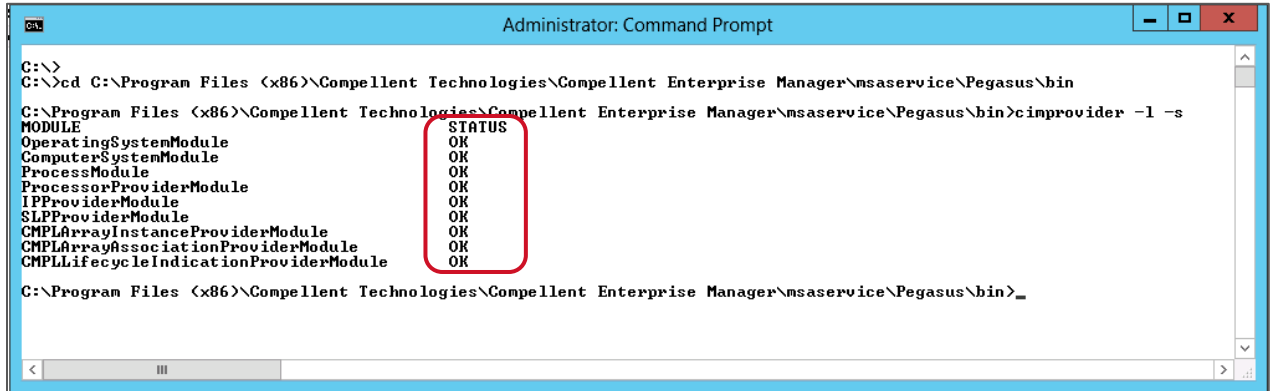
1. Revisit the prerequisite steps checklist in Table 1, particularly making sure the required TCP ports are allowed through the Windows Server firewall.
2. Temporarily disable the firewalls on both the Data Collector and SCVMM servers to simplify the environment, and re-attempt storage discovery. If storage discovery works with the firewalls disabled, revisit the firewall settings.
3. Verify that there are no network rules or policies in place on routers, firewalls, switches, or gateways on the local network that are blocking the necessary TCP ports between the Data Collector server and the SCVMM server. These servers should ideally be on the same subnet or VLAN.
4. Re-verify that necessary registry settings have been made on the SCVMM server for your version of SCVMM (SCVMM 2012 versions in particular).
5. Upgrade to the current release of DSM Data Collector and client to take advantage of the latest bug fixes if your version is outdated.
6. Stop and restart the Data Collector service on Data Collector server.
7. Reboot the server that hosts the Data Collector server/service.
8. Attempt storage discovery in SCVMM with SSL disabled in the discovery wizard (for troubleshooting purposes only). If storage discovery works with SSL disabled, revisit the registry changes associated with your version of SCVMM (SCVMM 2012 and 2012 R2 in particular).
9. Dell EM (prior to DSM 2016 R1) leverages OpenPegasus as the SMI-S provider. On rare occasion, a corruption issue may be encountered with OpenPegasus which will interfere with storage discovery. This can be resolved by following these steps:
  - a. On the Data Collector server, open a command prompt with elevated (administrator) privileges and type the following command to change to the Pegasus\bin directory:

```
cd C:\Program Files (x86)\Compellent Technologies\Compellent  
Enterprise Manager\msaservice\Pegasus\bin [enter]
```

- b. Type the following command from the bin directory:

```
cimprovider -l -s [enter]
```

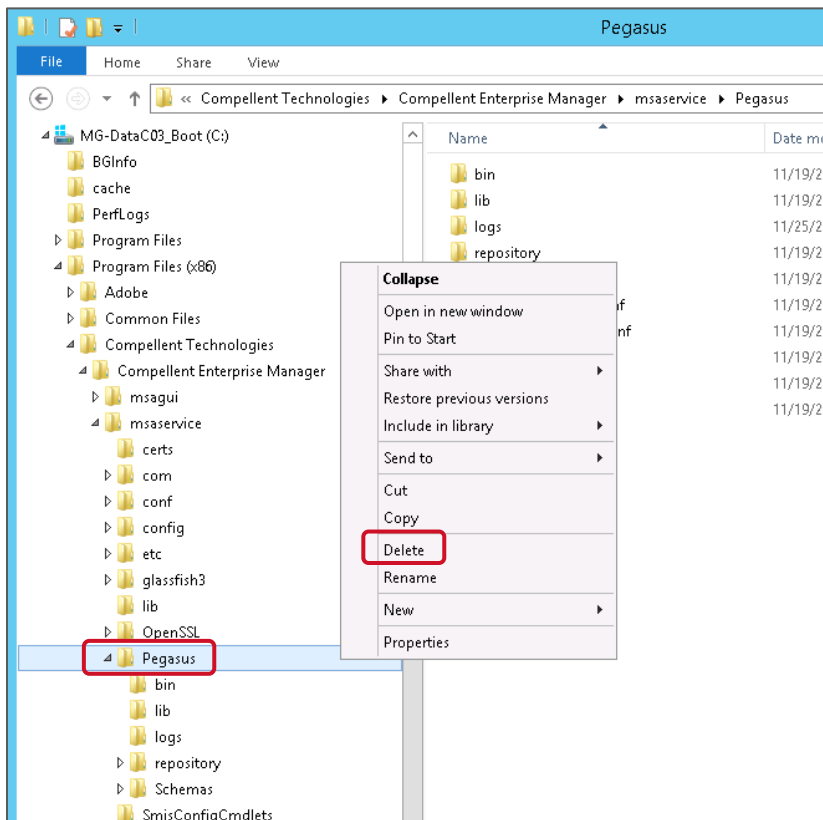
- c. Check the status of the OpenPegasus provider modules. They should report a status of **OK**.



```
C:\>
C:\>cd C:\Program Files (x86)\Compellent Technologies\Compellent Enterprise Manager\msaservice\Pegasus\bin
C:\Program Files (x86)\Compellent Technologies\Compellent Enterprise Manager\msaservice\Pegasus\bin>cimprovider -l -s
MODULE                                STATUS
OperatingSystemModule                 OK
ComputerSystemModule                  OK
ProcessModule                          OK
ProcessorProviderModule                OK
IPProviderModule                      OK
SLPPProviderModule                    OK
CMPLArrayInstanceProviderModule       OK
CMPLArrayAssociationProviderModule    OK
CMPLLifecycleIndicationProviderModule OK
```

- d. If any of the modules report an **Error** state, close the command prompt window and stop the Enterprise Manager Data Collector service on the Data Collector server.
- e. Once stopped, use Windows Explorer to delete the entire Pegasus directory:

C:\Program Files (x86)\Compellent Technologies\Compellent Enterprise Manager\msaservice\Pegasus





- f. Once the Pegasus directory has been deleted, start the EM Data Collector service. This will create a fresh instance of the Pegasus directory and its contents, and reregister the provider modules.
- g. Repeat substeps a through c of step 9 to rerun the `cimprovider -l -s` command. The modules should now be listed with a status of **OK**. Rerun the PowerShell script to verify that the SMI-S user and SSL certificate are configured correctly, then reattempt storage discovery using SMI-S.
- h. If the previous troubleshooting steps are unsuccessful, completely uninstall, reinstall, and reconfigure EM. Run the `cimprovider -l -s` command to verify module health before re-attempting to discover storage.
- i. Another way to check for possible Pegasus/SMI-S issues is to examine the logs in the following directory:

```
C:\Program Files (x86)\Compellent Technologies\Compellent  
Enterprise Manager\msaservice\Pegasus\logs
```

**Note:** For additional troubleshooting assistance with SMI-S and storage discovery, contact Dell Support.

## C Technical support and resources

[Dell.com/support](http://Dell.com/support) is focused on meeting customer needs with proven services and support.

[Dell TechCenter](#) is an online technical community where IT professionals have access to numerous resources for Dell software, hardware and services.

[Storage Solutions Technical Documents on Dell TechCenter](#) provide expertise that helps to ensure customer success on Dell Storage platforms.

### C.1 Supplemental documentation

Referenced or recommended Dell publications:

- [Dell EMC SC Series Storage Products](#)
- [Dell SCv2000 and SC4020 Arrays with SAS Front-end support for Microsoft](#)
- [Dell Storage Center Microsoft Multipath I/O Best Practices Guide](#)
- [Dell SC Series Virtual Fibre Channel for Hyper-V Demo Video](#)
- [Dell SC Series Replay Manager 7 and Hyper-V Best Practices Guide](#)
- [Dell SC Series Replay Manager 7 and Hyper-V Demo Video](#)
- [Microsoft Windows Server Best Practices Guide for Dell SC Series](#)
- [Dell SCOS 7.0 Data Reduction with Deduplication and Compression Guide](#)
- [Dell SC Series Synchronous Replication and Live Volume Solutions Guide](#)
- [Dell SC Series Live Volume with Auto Failover Support for Microsoft Demo Video](#)
- [Dell SC Series DR Plan for Hyper-V Demo Video](#)
- [Dell SC Series PowerShell SDK Cookbook](#)
- [Dell SC Series and Microsoft SCVMM Best Practices Guide](#)
- [Dell SC Series and Microsoft SCVMM Rapid Provisioning Demo Video](#)

Referenced or recommended Microsoft publications:

- [Microsoft TechNet Library](#)
- [Microsoft PowerShell Developer Network \(MSDN\)](#)